First-Person Shooter Game for Virtual Reality Headset with Advanced Multi-Agent Intelligent System

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ABSTRACT

We present a multiplayer first-person shooter (FPS) game with advanced intelligent non-playable characters (NPC) under computer control. The game is specially adapted for playing in VR headset so the simulator sickness symptoms are significantly reduced. The demo allows users to play with the other human and NPC players in a shooter game made in Unreal Engine 4. User can verify his/her game skills versus evolving human-like NPCs with a level adjusting model. The humanness of NPC was verified with Alan Turing game test beating 52% record from BotPrize'12 competition.

Keywords

Game artificial intelligence; reinforcement learning; virtual reality; first-person shooter; Unreal Engine

1. INTRODUCTION

Multimedia sources often declare that playing video-games leads to such negative effects as aggression, obesity and addiction. However, recent research proved positive influence of such activity on player's cognitive skills [2]. In [1] authors have shown that playing strategic video-games increases the impact. The only way to improve the importance of strategic planning component in command FPS is to make enemies more challenging. In a current state-of-art NPC usually acts as scripted/predetermined and uses full information from the computer engine, unavailable to a human player. Multiple synthetic algorithms were presented to compensate BOT (enemy NPC) supremacy over human drawing balancing entertainment and game challenge in virtual world.

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‡BOT motion and tactical map.

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Figure 1: Computer controlled player

We developed a comprehensive intelligent agent for FPS game learning its skills from in-game experience and making decision through the same cognitive patterns as humans. Frequently playing improves people's skills like training improve sportsman's indicators. So, instead of giving redundant information on environment state, we improved BOT playing skills by teaching it to make optimal decisions during game. We also created human-computer intelligent teams, in which each player could make its own decisions under supervision of a team goal expert system.

2. MODEL DESCRIPTION

2.1 Interaction in a Team

The environment state reflects all the information about the game state. BOT could obtain game states in the way human plays. Game states contain teammates health levels, amount of weapons, presence of an enemy in line of sight, etc. BOT can perform such actions as moving to strategic point, entering teammates group, looking around, targeting at enemy in line of sight (shooting or not), reloading.

We focused on a single mode behavior influenced by restrictions from cooperative strategy. At each tic BOT decides whether to continue current action or start another one according to environment state and fuzzy logic rules. We also improved results of [5] using reinforcement learning for cooperative planning of wining policies.

2.2 Motion and Tactical Waypoints

When developing a BOT with a human-like behavior, path planning, movement and its' smoothing appear to be almost the most essential parts of the AI. A human player can overlook some tactical mistakes made by AI but even minor unnatural movement can become a decisive factor to assess its' quality or distinguish it from a human player. Constraint path planning is also computationally very hard problem.

In [3] authors apply navigation via human traces such that BOT walks exactly like humans with some randomness. It does not solve the problem of BOT having its own decision pattern without direct imitation of human players' motions.

We use Voronoi-based navigation mesh combined with composite Bezier curves to smooth produced randomized paths. It leads to a better representation of map topology and provides an opportunity of tactical path finding. We use visibility and cover positions, curvature of path trajectory and general penalties for traveling in particular areas to implement tactical map properties. In addition, a path computed as a sequence of Voronoi cells tends to have a natural look even without further post processing stages.

2.3 Weapon Selection

During game session BOT should be able to select weapons for current in-game situation, depending on distance between the BOT and its opponent, players' motions, ammo, accuracy, etc. We train BOT using neural network that performs reinforcement learning [6]. There is a variety of benefits in such approach: BOT's behavior will be non-deterministic and similar to human players adapting combat tactics to different situations in ever-changing game environment. Combined with Kohonen self-organising maps for local goal selection and enemy position prediction, neural networks make FPS gameplay satisfy human player expectations of NPC skills.

2.4 Object Recognition and Targeting

The process of targeting and shooting is decomposed into the enemy recognition, targeting with respect to motor reflexes, and shooting after player's crosshair aim at recognized enemy. For the first part we use a toolkit for enemy recognition that outputs probability of an object to be an enemy player and its cover area [4]. The targeting was reconstructed via series of experiments with analysing mouse-tracking in game tests. Finally, we discovered correlation between in-game events and aiming techniques, and use the following three: target lock (locking the player's crosshairs on the closest target by manipulating his pitch and yaw), target gravity (choosing an area of targeting and then the closest target, if several enemies are recognized), or sticky targets (aiming at the moving targets following its motion).

3. PLAYER EXPERIENCE

We give a user HTC Vive headset and controllers, emulating real weapons. User participates in a deathmatch competition with limited time. We allow user to play with both, humans via Internet and BOTs with human-like behavior. The BOTs' skills set is adapted to human-player game level during the game. We implement technical demo providing AAA graphics quality with the use of Unreal Engine 4 under custom license agreement.[1] We evaluate the BOT model through game Turing test obtaining 80% humanness judged by humans playing the demo FPS game.

[1] `https://www.unrealengine.com/custom-licensing`

Figure 2: VR FPS Game Demo

The demo exhibits a first-person shooter video-game with reduced simulator sickness and advanced intelligent enemies. We present a challenging gameplay that may be of great interest to game developers and users of any game experience.

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