Emulating Real World Strategic Intelligence Using Artificial Intelligence In Gaming

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Abstract- *In the modern world, games are considered a distraction and a form of entertainment/amusement at most. However, it is observed that games stimulate the intellectual corners of the human mind and can make a person think strategically & develop dynamic-decision making, which enhances their professional life. To further this goal, we will create a game environment, where the player can make decisions for themselves and the entire team, which in-turn affects the environmental reaction to the player. This game will be a Single Player Strategic First Person Shooter with a deathmatch mode consisting of two teams in combat, where the goal of each team is to eliminate the other team. The map design of the game will consist of two bases for each team, with added obstacles of multiple pathways. Being a single player game, all the other participants will comprise Artificial Intelligence Agents that will take actions based on Decision Trees. Furthermore, these agents will learn the gaming patterns of the player and try to come up with counter-strategies with the use of Reinforcement Learning. Fuzzy Logic will be used to mimic the probability of human errors. This system will comprehend the idea where Decision Making for Artificial Agents will differ with every player.*

Keywords- Dynamic-Decision making, game environment, Strategic first person shooter, Artificial Intelligence, Decision trees, Reinforcement Learning, Fuzzy Logic.

I. INTRODUCTION

Games can be a good way of improving certain skills but also in a fun, entertaining way. Strategy games are a good way of improving decision making skills. They also require a high sense of situational awareness. The development of this project focuses on these aspects where a player will have intellectual stimulation in an environment designed to be amusing. There are various Fundamentals that are employed in this project as discussed below:

1. NPC: NPC (Non Player Character) are added to the game to add some dynamics to the environment. NPC are basically AI agents programmed to act in a certain way in a particular environment. They are mainly used in open world games so that the game gets some depth to it and also the world created feels real as there is constant interaction or activities performed by these NPCs.

2. A* algorithm: It is a graph traversal and path search algorithm, which is usually utilized in many fields of computing thanks to its completeness, optimality, and optimal efficiency. It has its eminent applications in game development.

3. The analysis of computer algorithms that refine themselves over time through practice is known as machine learning (ML). It's regarded as a subset of AI. Machine learning algorithms build a model based on training data in order to make predictions or decisions without being explicitly programmed to do so.

Objectives

1. The project holds a key objective to accomplish a simulation of teammates and opponents based on the player's gameplay.
2. Building a virtual simulation of a competitive game environment playable with a single player.
3. To build worth competing Non-Player Characters for a competitive game.
4. Developing NPCs to build effective counter strategies.

Scope

The scope of the project is to build a system which will help an individual to train himself to compete in a game at the level of his own skills.

Artificial Intelligence agent aims to:

1. Follow all the player's commands simulating an effective communication between teammates.
2. Decide in pregame to attack from a site depending on previous rounds intel.
3. Find enemies on the map.
4. Keep on shifting to new corners to hold and defend a site.

5. Prepare strategies on the basis of the current team situation.
6. Hide at the map corners to panic the attacker.
7. Use weapons in different ways depending on the shooting position and area.
8. Plan to headshot to deal more damage.
9. Apply the strategies for strafing to dodge bullets.

Deliverables are set as follows:

1. To Build 3D character model
2. Building the game map
3. A playable game
4. Adding Artificial Intelligence agent
5. Applying Reinforcement Learning for rounds

II. LITERATURE REVIEW

In this chapter various different papers that were surveyed are presented. It presents various techniques used in different games and technologies that make use of AI.

1. Artificial Intelligence and Deep Learning in Video Games A Brief Review(2019)-

This gives us an idea of the start of AI in games, all the way back in 1970 in 'Computer Jam'. Supervised learning, Convolutional Neural Networks (CNN), and Recurrent Neural Networks (RNN) are currently the most popular AI/machine learning algorithms used in games. Neural Networks allow AI systems to become smarter and more useful, as OpenAI's game-playing bots demonstrate. It also explains the first major milestones in AI gaming, such as IBM's Deep Blue, which were AI breakthroughs. This paper provides an introductory literature review of these core fields of research as applied within a video game context.

2. AI Wolf Contest – Development of Game AI Using Collective Intelligence(2018)-

The author describes the development of an artificial intelligence (AI) player for the communication game Are You a Werewolf? (AI Wolf). The Werewolf game is a communication game that necessitates the use of many AI technologies, including multi-agent teamwork, deliberate reading, and knowledge of the theory of mind. Communicative AI player is developed so that the game can be played with humans. First, a platform was created for creating a game-playing AI for a competition. Then, to help the creation of AIs that can play Werewolf, a platform for an AI game competition with simplified rules is developed. The paper describes the competition's mechanism and analyses the outcomes.

The game server library is offered by Java. Agent-building libraries are offered by Java, .NET Framework, and Python. During the game, agents interact with one another using the AI Wolf Protocol, which is a condensed version of the AI Wolf Protocol. In the game the AI agent should change its behaviour according to the role it's assigned. The possible requests differ for each role.

3. General Video Game AI: A Multi-Track Framework for Evaluating Agents, Games, and Content Generation(2019)-

General Video Game Playing (GVGP) is a project that aims to create an agent that can play several video games without human involvement. The General Video Game AI (GVGAI) competition system was developed and published in 2014 to provide researchers with a generic open-source and easy-to-use tool for evaluating AI methods with games created using Video Game Description Language (VGDL) (VGDL). VGDL is a text description language that allows games and levels to have two-dimensional, arcade-style, grid-based physics. Either the agents must play a series of uncertain games with or without access to game simulations, or they must develop new game levels and rules. This survey paper discusses the VGDL, the GVGAI method, and the common use of the GVGAI structure in research, education, and competitions. It provides the overview of different efforts put in by the community on the GVGAI framework for AI in gaming.

4. Artificial intelligence moving serious gaming: Presenting reusable game AI components(2018)-

This article discusses how artificial intelligence (AI) can be used in serious games. It presents a set of advanced game AI components. The selection focuses on Player Experience Modelling (PEM), Natural Language Processing (NLP), and advanced Non-Playing Character modelling (NPC). PEM has components like

Real-time facial emotion recognition which uses artificial emotional intelligence to unobtrusively cover unbiased facial expressions of emotion from any image, either from a still, a video file, a video stream or a webcam, Stealth assessment which uses machine learning technology to provide probabilistic reasoning over the learners' knowledge and skills levels by exploiting meaningful data which is collected during gameplay, Adaptation and assessment (TwoA) offers a dynamic game difficulty balancing

mechanism, which automatically matches the difficulty of the player's task to the player's skill

NPC has Sentiment analysis which uses deep learning with either Convolutional Neural Networks (CNN), Recurrent Neural Networks (RNN), Automated essay scoring for various languages a separate NLP pipeline model was created, using language specific dictionaries, stop words elimination, word lemmatization, and part-of-speech tagging, Role play character (FAtiMA) toolkit facilitates the inclusion of a dynamic model of emotions affecting character looks as well as the way it acts along with showing how the player's responses are evaluated.

III. IMPLEMENTED SYSTEM

We will be discussing various roles of the system in overview. Figure 1 is a simple block diagram which shows roles in the system and the relationship are actions which one role takes on another.

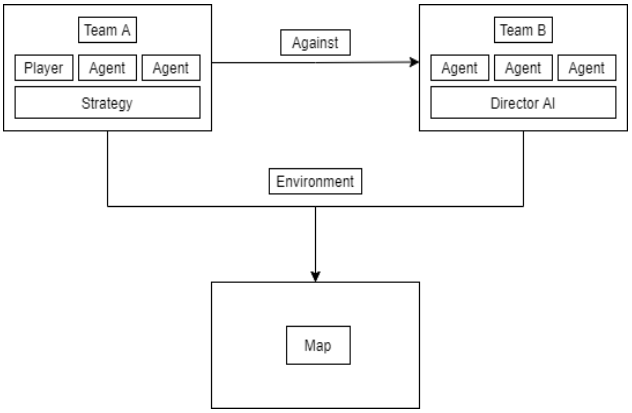

Fig. 1: Basic Elements of the System

A brief discussion about them is as follows :

1. *Team:* There are namely two teams, team A and team B. The difference between them is their composition. Team A consists of a human player and two AI agents and team B consists of three AI agents all together. Currently for the simplicity the number of teammates are kept three number of agents or number of human players can be changed in the foreseeable future.

2. *Player:* Player is the only entity which is human in the game. A player has the ability of controlling the character model or player model using mouse and keyboard. Apart from that major dynamic that a player adds to the game is that he decides the strategy for his team. He can direct the AI agents using the map to hold positions in order to counter the opposite team.

3. *Agent:* An agent is an AI bot which is programmed in order to play in various parts of the map, aim at the enemy player or an enemy AI agent and control movements of their character model.

4. *Strategy:* A strategy can be a game plan or a way of approaching the game. Strategy is decided by the human player by placing his teammates in specific positions on the map allowing them to counter the enemies.

5. *Director AI:* Director AI can be explained as a counter strategy made by the computer against the player. Director AI has the ability to overwrite the current actions performed by a bot and place a particular action which can benefit the team.

6. *Map:* Map is the environment in which the game is going to take place. Maps are made intricately with a thought that both teams have equal advantage towards each other. Maps have a proper symmetry and places where some players may have advantage or disadvantage in equal numbers.

7. *Against:* This relation indicates team A is against team B. The game continues until all the players of one team are totally eliminated.

8. *Environment:* Environment is the place in which the fight takes place which is the map. On map mainly sites are specialized places where fights can take place.

In Fig 2 we can see various entities and their attributes mentioned. These attributes are either some properties or actions that the entities do or the Algorithms/Techniques used to implement them. Also the connectors are used to determine the relationships between the entities.

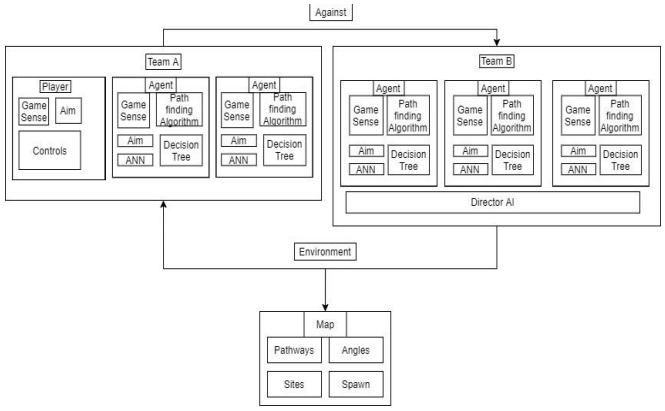

Fig. 2: Implemented system architecture

A brief description about the attributes of entities is as follows:

1. Decision Trees:

Decision trees are specialized to hold various actions that are generally expected from a real player when he approaches a section in the map. Every bot in the game is hardcoded with these decisions and these can be only changed by the director AI in team B and the human player in team A.

2.Path finding Algorithm:

Path finding algorithms are activated as soon as the agent gets a command from his director AI or human player. This algorithm helps the player find the shortest path to his objective position in the map. Mainly where gaming is concerned A* algorithm is widely used in the industry.

3.Game sense:

Game sense is using prediction to identify the environment around you, predict possible spots for conflict with enemies and how you as a player will react to the possibility of conflict while using their environment. On the human player side game sense comes from constantly playing various games and developing some skills like which position is best to outplay his enemy or taking an advanced position. The same skills can also be implemented by AI using decision trees and reinforcement learning.

4.Aim:

This is the accuracy with which a player hits a target as soon as it reaches his visual cone. Aim of an AI can be set by the player to increase or decrease the difficulty. This is analogous to the agent being skilled/unskilled.

5.Controls:

Controls are basically mouse and keyboard bindings used by the human player in order to control the character model as well as to shoot a target when he sees it. General controls are Move left, move right, move forwards,move backwards, strafe left, strafe right and shoot.

6.Pathway:

Pathways can be described as tracks using which various parts of the map are connected. Players can use pathways to change their position in the map.

7.Angles:

Angles are visual cones with respect to the in-game camera. It is the amount of area which can be seen by a player. Objects in the map can obstruct the angles.

8.Sites:

Sites are special areas in the map where fight between the enemy team is expected to happen. Sites are specially designed so that each player can have multiple ways to play a certain area rather than having a boring plain field. Sites can be made more interesting using boxes to take cover and some areas with elevation.

9.Spawns:

This is the initial place where players appear in a map. Both the teams have different spawn locations and this the starting place from where a team can start approaching the game.

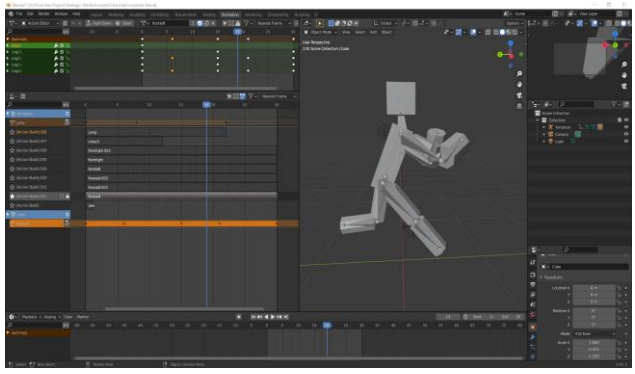

Fig. 3: Character Animation

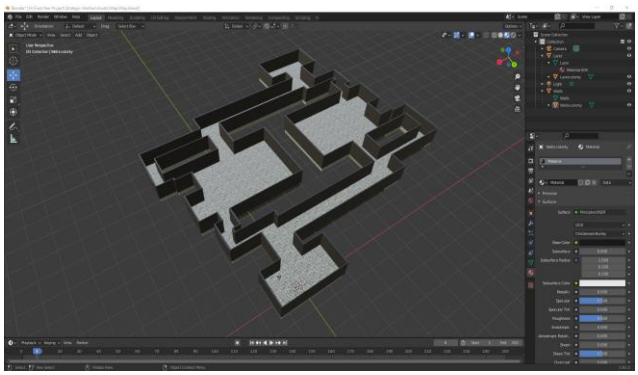

Fig. 4: Map Modelling

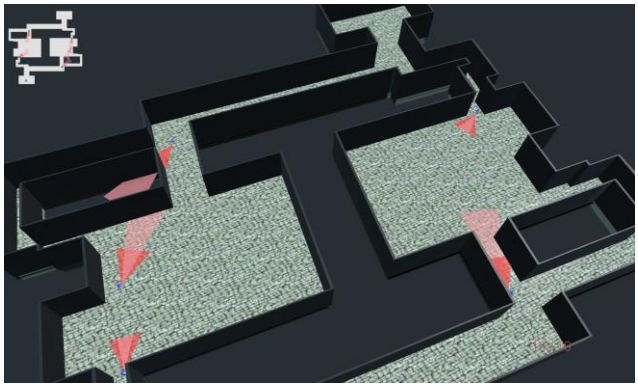

Fig. 5: AI Searching for Enemy

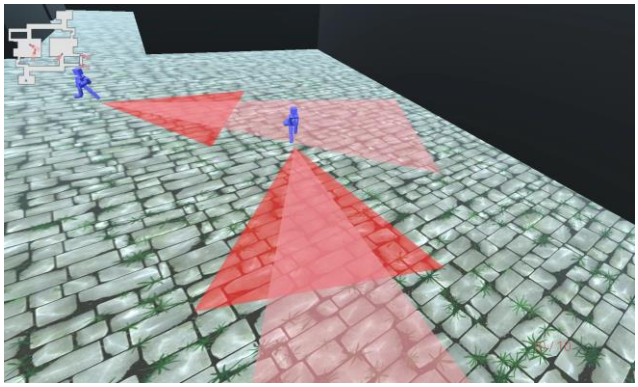

Fig. 6: AI Following Enemy

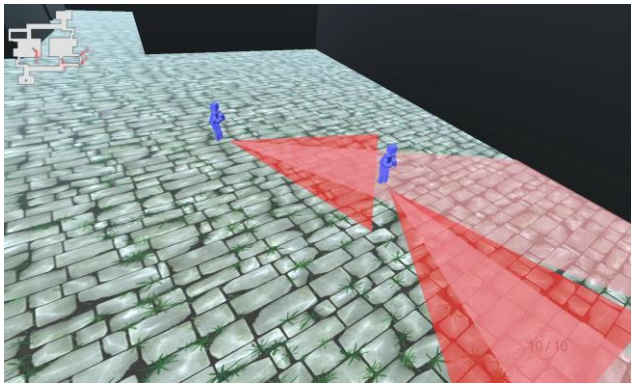

Fig. 7: AI Shooting Enemy

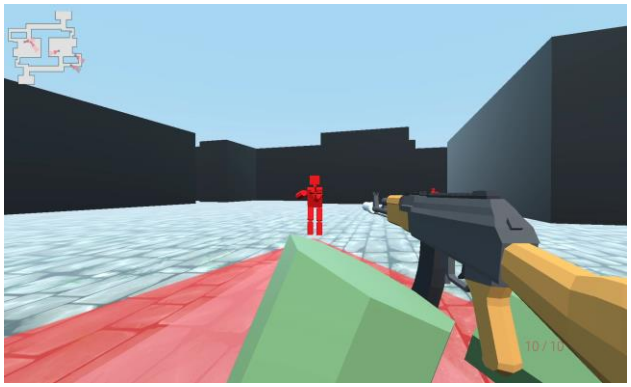

Fig. 8: AI Shooting Player

IV. REQUIREMENT ANALYSIS

Sample Dataset Used

There won't be any existing or an external dataset used as the data required to train the algorithms used, i.e., for ANN and Reinforcement Learning will be generated on the fly.

Dataset is generated by putting AI in different situations. This can only be done by playing the game itself and simulating those conditions.

Reinforcement Learning is similar to how a human learns, i.e., by being rewarded for taking correct actions and being punished for taking incorrect actions. This will generate the data during the gameplay and train the brain(Artificial Neural Network in this case).

Hardware and Software Specifications

The experiment setup is carried out on a computer system which has the different hardware and software specifications as given in Table 3.2(a & b) and Table 3.3 respectively.

Table 1. Minimum Hardware details

Processor	x86/ARM system
HDD	2 GB
RAM	4 GB

Table 2. Recommended Hardware details

Processor	x86_64/AArch64 system
HDD	2 GB
RAM	8 GB

Table 3. Software details

Operating System	Windows/Linux/Android
Programming Language	GDScript and C++

V. SUMMARY

A brief introduction to our system is given along with its objectives and scope. Multiple research papers were studied and introduced us to various ways of incorporating AI in gaming. We analysed the difficulties presented in the papers which helped us to mitigate the issues in our system. We were able to integrate various different techniques together which helped in making the system flawless to the best of our ability. A detailed overview is mentioned about the implemented system. These are explained with a proper functional block diagram in a simple and composite version of the information. This paper also highlights how gaming can not only be fun but also helpful in training the brain to perform various important tasks like decision-making, critical thinking etc, these are crucial skills in real life.

VI. ACKNOWLEDGMENT

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