# Artificial Intelligence Based Path Finding and Decision Making in First Person Shooting Game

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*Abstract*— **Artificial Intelligence (AI) is one of the essential parts of gaming industry. In this paper, we have examined how Artificial intelligence technology is effectively used to solve the problems that arise while developing a game and integrate new features to the game. In this research paper, two algorithms are examined they are, path finding of the bots and bots decision making. Few AI techniques are discussed in this paper and how these techniques are used to provide solution to the problems that occur in the games. These techniques are also taken into consideration to provide new features into the computer games. This paper aims to discuss on the Finite State Machine and A\* methodologies, which helps in the decision making of a bot and also to find the path towards the goal.**

**Keywords**— **Artificial Intelligence in gaming, FPS, FPS games, Technique Used in FPS games.**

## I. INTRODUCTION

Gaming industry has evolved from the text based games to the open world AI games where the player gains the ability to interact with the bots and obtain a particular response. Computer gaming is one of the fields where AI has been effectively used in a revolutionary manner. Gaming has always been dependent on the hardware resources in order to execute a particular task. As the new hardware gets developed, the gaming industry makes the full utilization of the hardware resources. To develop a computer game, User inputs, graphics rendering, playing audio and games Artificial intelligence should work in harmony for leveraging amazing experience to the players [1].

First person shooter game is a genre of game which is played from the point of view of the players. This paper aims to discuss on how the FPS games bots can be enhanced for the entertainment of players. FPS games makes players to feel like they are actually in the immense and complex world of the computer games [1]. The FPS games give the adventurous experience to the players as if they are holding weapon on their own and shooting with that weapon. Just because of this adventurous feeling, the FPS genre generates millions of dollars of revenue for the developing gaming industry.

One of the example of the FPS genre is DOOM. DOOM was first launched in 1993 by ID Software LCC [1]. As soon as the DOOM was released it set up a benchmark for all the FPS games. It made itself a trigger for the upcoming FPS games. The AI bots DOOM was created in a simple manner that the bots used to attack the players as soon as they see them or just walk around without any goal and hit if they encounter some other bot.

With the influence of the DOOM the market of the FPS games has expeditiously increased. Now there are diverse number of FPS games available in the market. Since it is the very start, game developers have spent most of their time and efforts on the design and graphics of the games. They spent time on the detailing of the game is just to attract more and more customers with good and realistic graphics. Because of this reason, AI part has been neglected until now. Game developers have started working on the AI part and spend their time and efforts mostly to create an AI that will satisfy the requirement of any human player. In doing so they have to be careful, if they make AI too weak then it will affect the game and experience of the player while playing it. But if they make the AI too strong then that will also make players to lose the interest in game as they cannot beat it. So the game developers need to keep these things in check and make an AI technology to satisfy the players experience and make them feel like they are playing against a real human [3].Rest of the paper is divided into certain sections: - Section (II) talks about the related research works done and the references that have been considered for this paper. Section (III) talks about the proposed path finding algorithm using A* algorithm. Section (IV) talks about the proposed decision making algorithm for bots using FSM (Finite State Machine). Section (V) gives you an analysis of the proposed decision making algorithm. Section (VI) covers the conclusion of this paper. Section (VII) provides the acknowledgement and the last section, Section (VIII) contains the references of this paper.

## II. LITERATURE REVIEW

A popular game F.E.A.R. 2 has one of the best Artificial Intelligence techniques used for creating the Bots. It has used the two most common Artificial Intelligence techniques: - A* algorithm for path finding and FSM (Finite State Machine) to create states and give them actions to perform. The use of FSM is to control the actions and the movements of the bots. A* plan the path for the Bots or the character. It calculates the shortest path in order to reach a certain point. It is used to plan and sequence the actions of the characters as well as to plan the pathing. F.E.A.R 2 use these techniques in a very unconventional manner. The F.E.A.R. 2 has 3 states: - Goto , Animate and Use Smart Objects. [2]

There are other techniques as well that are being used to create an AI for FPS games. Some of the techniques are so advanced that they make AI learn how to perform in the future from the events that has happened. Different approaches are: - Neural Networks, Genetic Algorithm and Turing test.

The purpose of Turing Test in game is to make it as an intelligent and a believable AI system. The trusted AI system which tends to make a human player determine whether he/she is playing against

a bot or an actual human. By using Turing test we make AI perform mistakes intentionally so that the human think that he/she is playing with another human and not with an AI [7].

Neural Networks and the Genetic Algorithm has become an important part of the machine learning. These 2 techniques are used to give AI a biological approach. Biological approach is taken by the Genetic Algorithm to solve the problems. It takes a problem and continually evolves it until the problem gets an optimal solution or get close to the optimal solution [8].

Neural networks mimics the biological learning. It is based on how we think and how the human brain works. It has predefined structure that act as neurons and a specified number of links [8].

These are few approaches used in order to achieve a fully working AI in FPS games. These techniques make fool out of a person and makes them think that the computer opponent is an intelligent entity or a human player.

There are many ways in which AI can contribute to the computer games. Most popular ones are the unit movement, spatial reasoning, resource allocation, target selection, and many more. Even animation and audio used in games comes under this category

## III. ARTIFICIAL INTELLIGENCE BASED PATH FINDING ALGORITHM

There are many methods to make AI bots move, one of those methods is A* algorithm. A* algorithm is used to calculate the least cost of the shortest path that is taken towards the goal. This algorithm is an important part of the computer games as it is used for the path finding of the bots [5].

The A* algorithm works exceptionally well when it comes to the path finding of the bots but it has some drawbacks too. One of the drawbacks is that the path which it produces is not always the best path, it is somewhat a jagged path which a human would not choose.

The best use of A* path finding algorithm comes under the gaming section. Computer games make full use of this algorithm. A* algorithm is very flexible and game developers like to use it for that very specific reason. Unlike any other algorithm it not just find blindly search for the path towards the goal rather it looks for the best possible path and even do backtracking if it has to. Its ultimate use is to find the shortest path between the two nodes [5].

A* algorithm is used find the best possible path to traverse between two nodes in a graph. The node stores the information that is crucial for the A* algorithm like, graph positions. There are many factors that it will take into account to travel a path like how much energy it needs [5].

The three main characteristics of A* algorithm is Fitness, Goal and heuristic. These three characteristics are denoted by a, b and c respectively. b is the cost of the travel node that starts from the startnode and ends at the goalnode. c calculates the cost of the node from startnode to goalnode. a is the addition of the b and c which estimates the   cost of a path that goes through the node. A algorithm maintains an Open*list for those nodes which have not been visited yet and a Closed*list for those nodes which have been visited [5].

Pseudo code for the A* algorithm [5].

1. Let P = the starting point.

2. Assign a, b, and c values to P.

3. Add P to the Open list.  At this point P is the only node on the Open list.
4. Let B = the best node from the Open list (best node has the lowest a-value).
   a. If B is the goal node, then quit.  A path has been found.
   b. If the Open list is empty, then quit.  A path has been found.
5. Let C = a valid node connected to B.
   a. Assign a, b, and c values to C.
   b. Check whether C is on the Open and Closed list.
      i. If so, check whether the new path is more efficient (lower a-value).
         1. If so, update path.
      ii. Else, add C to Open list.
   c. Repeat step 5 for all valid children of B.
6. Move B from the Open list to the Closed list and repeat from step 4.

## IV. ARTIFICIAL INTELLIGENCE BASED DECISION MAKING ALGORITHM

There lies many techniques that are used to create a decision making algorithm for AI bots like, rule based, goal based, decision tree. Another One which we going to talk about in this paper is the Finite State Machine (FSM). The main aim of this paper is to create an AI that resembles a behavior just like of the human. And this can only be applied by using the Finite State Machine (FSM) [6].

The main component of the FSM are the states and transitions. Every state which is present in the FSM is interconnected with the transitions. When the AI receives an input from its surrounding, it changes from the current state to the new state and performs the reaction according to the inputs received.

This kind of change in states shows how the human changes states. Example: - if we are feeling hungry (input initiate transition) then go and eat something (change state). This reflects the behavior of a human being. Thus this explain how the FSM works and changes states and make decisions.

The Finite State Machine has 6 states present in it: -

STAND: - The bot is standing.
RUNNING: - The bot is Running or searching for an enemy
ATTACK: - The bot attacks player.
COVER: - Bot Seeks Cover.
KILL: - Bot kills an enemy and perform the suitable action after that.
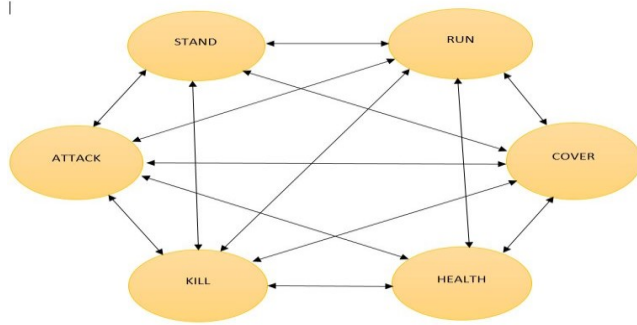HEALTH: - Bot looks for health or hides to regen when low.

Fig 1. Basic action performed by the Bots.

The transition consists of 9 different inputs that will be received from the surrounding:-
Seen an enemy
Not seen an enemy
Bots are healthy
Bots are not healthy
Bots is being damage
Bots is not being damage
Bots are attacking
Bots are chasing.
Bots taking cover.

These transitions will tell in which state the bots will be when they are put in some condition or some condition comes up to them like, seen an enemy

Pseudo Code:-

- Game begins.

- 9 bots and 1 individual player is put into the stage with bots. Total of 10 entities.

- The transition will be between 0-8.
  0 == Seen an enemy
  1 == Not seen an enemy
  2 == Bots are healthy
  3 == Bots are not health
  4 == Bots is being damaged
  5 == Bots is not being damaged
  6 == Bots are attacking
  7 == Bots are chasing
  8 == Bots taking cover

- Bots search for enemies

- Bots found the enemy and attacks enemy.

- If bot kills an enemy.
  o Goes to the nearest health pod if it has taken damage.
  o Goes back to step 3.

- If bot doesn't kill an enemy and takes damage.
  o Runs to the nearest cover.
  o Or will look for nearest health pod.
  o Goes back to step 3.

- If bot encounters 2 or more entities at same time.
  o It prioritize shooting at the one with low health.
    - If the low health enemy runs away it targets other enemy with low health.
    - If there is a clash between low health enemies then it will choose at random.
  o It will compare its health with the other enemy and do the following action.
    - Bothealth > the other enemy. Keeps shooting at it.
    - Bothealth < the other enemy. Runs for cover and will look for health pod.
    - Goes back to step 3.

- If bot see low health enemy running alone.
  o It will chase to shoot down the enemy

- If bots or players dies.
  o It will respawn within 10 seconds.
  o Go back to step 3.

## V. ANALYSIS OF FIRST PERSON SHOOTER GAME

The flow chart below shows the basic analysis of how the bots will change its states when they will encounter an enemy. What kind of action will the bot choose and what particular action they will perform.
What's happening in this analysis is that the bot is searching for the enemies. If it finds an enemy then the transitions in states will happen and it will perform 2 actions, either it will kill the enemy or while engaging enemy it will take lethal damage and need to run. When the bot runs then further transactions takes place. These transactions are taken shown in the flowchart below.
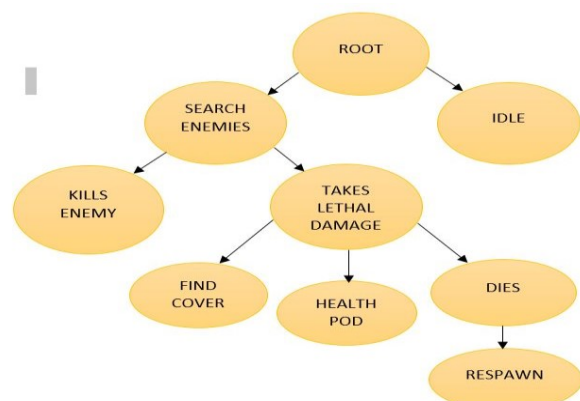


Fig 2. Analysis of bot decision making

## VI. CONCLUSION

This paper presents a pseudo code for the movement of Bots and the actions they will perform. A code for A* algorithm is also implemented for the pathing of the Bots. A pseudo code for the change of transactions of the bots is also deduced by using FSM. The pseudo code which has been deduced make the bots act like

actual human beings. This experience is what makes FPS gaming so fun, making humans believe that they are playing against other human beings offline.

In future, many more things can be done to make the AI bot better and the code can be made better for sure. Possible more new techniques will be created to make the AI bots move and react more like a human being.

## VII. ACKNOWLEDGEMENT

## VIII.    REFRENCES

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