

Competitive Lag Compensation Featured Multiplayer Shooter Game

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Abstract—This research develops a fast-paced multiplayer shooter game using Unreal Engine 5, a cutting-edge technology. The project's primary goal is to create a fully functional game that is entirely for entertainment purposes. Several game modes, including Capture the Flag, teams, are included in the project. Depending on the game modes, the players are offered a wide variety of objectives. The overarching goal of every game mode is to eliminate the opponent and score the most points possible to win. The online subsystem of the Unreal Engine is used to enable multiplayer gameplay, and the plugin developed allows players to host or destroy sessions. The lag compensation techniques used in this project attempt to compensate for lag encountered during online gameplay and provide the player with a smoother experience. The project ensures that the players have a fun time with their friends or team members by providing a diverse range of weapons to choose from and graphical prowess.

Index Terms—Multiplayer, Lag Compensation, Shooter

I. INTRODUCTION

Online gaming accounts for a sizable portion of the gaming market, and it is a massive industry that allows businesses to make enormous profits. On a daily basis, players spend countless hours leveling up their characters and interacting with the player community. Games such as CS:GO, Apex Legends, GTA, and DOTA have demonstrated the potential of online gaming and serve as an ideal model for other gaming companies. Millions of players around the world regard videogames as one of the most engaging activities. According to the website gamesindustry.biz stated that during the social

isolation period [1] shooters, the second-largest genre after MOBAs, experienced the most growth, increasing their player share on PC by 40% since December to a total of 46% of all players. On a daily basis, users continue to actively play shooter games. E-sports organizations continue to organize a variety of competitions that allow players to express their love of online gaming. The progression system and the constant need to win the game and achieve the highest score possible are the primary reasons why shooter games are addictive. This desire drives the player to keep playing until the winning point is reached. Players yearn for mastery in the game as well. They want to achieve a dominant position in the game so that no one can beat them. Because of these compelling reasons, even when the task of shooting is

repeated, the players are not bored. Financially, companies such as Activision have reaped enormous profits by developing the popular franchise known as Call of Duty. This shooter franchise is beloved by fans and is still being played today. The active player base motivates many companies to continue developing games in the shooter franchise.

II. BACKGROUND

With the popularity of games has come a considerable increase in game engines, and there are now numerous game engines available to game developers. According to Roundhill Investments [2] there are 63 trackable game engines that developers have used to produce their games, just on Steam. These can be split into two groups: proprietary and open-source. The open source gaming engines are accessible to everyone, are free to use, and help the industry grow. Unreal engine 5 is a well-known gaming engine that is free to use and was just launched by the Epic Games Store. Although this game engine is not entirely open source, you are nevertheless welcome to contribute to its development. According to a blog published on Unreal engine website [3] it clearly has the potential to transform the way that video games are developed in the future, and makers of cinema and television, live events, architecture, automobiles, and other media may all celebrate. It is undeniable that the game engine will have a significant impact on how games are traditionally created. So, after numerous evaluations of various game engines, we believe Unreal Engine is the best game engine for the development of our Multiplayer Shooter Game. We believe that the vast availability of free assets, comprehensive documentation and numerous other features will assist us in developing a fully functional shooter game.

Our game development strategy would begin with the creation of a multiplayer plugin. This plugin would allow players to host or join online sessions. The plugin would consist of several files that would be linked to the online subsystem of the Unreal Engine. The players of the game would be facilitated with a startup menu where in the player

are provided with two buttons mainly "host" or "join". After working upon the plugin, we would proceed towards implementing main character animations, remote procedure calls for certain functions, weapon firing, several different game modes such as "Capture the flag", "Teams". Because our game will use a client-server model to connect and the clients across the internet, RPC will play an important role. According to the Unreal engine documentation RPC is given as [4] RPCs (Remote Procedure Calls) are calls to functions that are made locally but are carried out remotely on a different machine from the one making the call. Along with some additional functionalities, we would move forward with our main goal of implementing the lag compensation feature. According to Valve, Lag compensation [5] is described as a technique for normalizing server-side each player's experience of the world when their user commands are carried out. Lag compensation can be compared to going back in time on the server and seeing how the world appeared at the precise moment the user took a certain action. This feature would compensate for any network lag that occurs while the user is playing the game.

III. RELATED WORK

In his study work, Steven W. K. Lee discusses the significance of lag compensation and the ways in which conventional lag compensation strategies impair online multiplayer gaming players' performance [6]. As a result, the use of novel systems is required to reduce unnecessary lag experienced by the players. The Unreal Engine Online Subsystem includes built-in features that help you create a fully functional game with minimal lag. Another major issue that players face is the issue of cheating and exploitation while playing online. Cheating is the act of using automated tools to gain an advantage over other players. Ruan Spijkerman in the collaborative research work proposes AI tools for detecting cheats [7]. While the concept is without a doubt a fantastic option, the Unreal Engine Online Subsystem's built-in Security feature makes it far more practical for smaller team of developers. John Zhang in the research [8] develops a multiplayer game named "Maze Escape" using Unity and describes the use of Photon which is a tool for adding multiplayer functionality to Unity games. Relying on third party technologies to create multiplayer functionality for the game becomes a hassle. Instead, our game relies on an effective approach that makes use of the online subsystem that is already incorporated into the Unreal Engine and offers all the required functionalities.

IV. IMPLEMENTATION

A. Multiplayer Plugin

We are creating a multiplayer plugin for the purpose of implementing multiplayer functionality in our game. In Unreal Engine, a plugin is a modular package that can be added to a project to extend its functionality. Inside our plugin, there are multiple classes that perform various jobs such as handling sessions. Along with plugin, we are also creating our own subsystem because subsystem provides several benefits listed in the documentation [9]. Headers files of our plugin are kept public whereas the cpp file are private. Several functions such as CreateSession, FindSessions, JoinSession, DestroySession

are implemented and their working is listed below.

- CreateSession: If session already a session exists, then it destroys that session and creates a new session
- FindSessions: It finds for an existing game session on the internet
- JoinSession: It captures the session information and allow to join the game session
- DestroySession: This function is called once the game playthrough is finished to destroy the existing session

B. Level Design

We are using "Unreal Engine Learning Kit" assets from the marketplace of the Unreal Engine Store for the lobby level. A range of assets are accessible to choose from in order to construct the lobby level. The assets come in a variety of categories, like architectures, which mostly consist of floors, gates, platforms, and ramps. The asset pack also includes environmental assets including clouds, islands, and foliage. The levels are split into three main parts

1. Game Startup Level
2. Lobby Level
3. Main Level

Game Startup Level:

This is the level where the player would be directed after starting the game. The player would have two options mainly "Join" and "Host". Using the "Join" functionality the player can join an existing session available on the internet. And using the "Host" functionality the player can create their own session for other players to join. This level design involves firstly the creation of a Menu using the widget blueprint. In Unreal Engine, a widget blueprint is a visual scripting tool used to create user interfaces (UIs) for games and applications. It allows developers to create UI elements such as buttons, text boxes, sliders, and more, and to define their behavior and appearance. After binding the Menu to the game's starter level we obtain the following



Lobby Level:

In video games, the lobby level is a virtual area or room where players can gather before the start of a game. In some games, the lobby level may also provide a tutorial or training mode for players to learn the game mechanics or practice their skills. Once the player selects the desired game mode from the main menu, the player is then transitioned into the lobby level. A player then waits for connections from other players in the lobby. The user is free to walk around the lobby and is then

taken to the Main Level after connecting with other players.

Main Level:

The primary level is where the players interact and engage in various game modes. Several weapons that can be picked up and used are scattered around the level. Also, the level has a number of power ups that temporarily improve the powers of the player's character. The level's environment will change depending on the game modes. For instance, if the game mode is "Capture the flag," flags would spawn in the stages to accomplish the objective. We used a map that is freely available on Epic Games Store[9]

C. Player Character

Animations: After the level design is finished, using an animation state machine and blendspaces is crucial to implementing player animations. The animation state machines are used to create highly dynamic and responsive animations that react to a variety of inputs and events. In Unreal Engine, an animation state machine is a visual tool used to create complex animations for characters and objects. A blendspace is used to create smooth transitions between different animations based on a set of input parameters, such as movement speed, turn rate, or other factors. Following Fig(2) and Fig(3) represents different states of player character for unequipped and equipped weapon state machine.

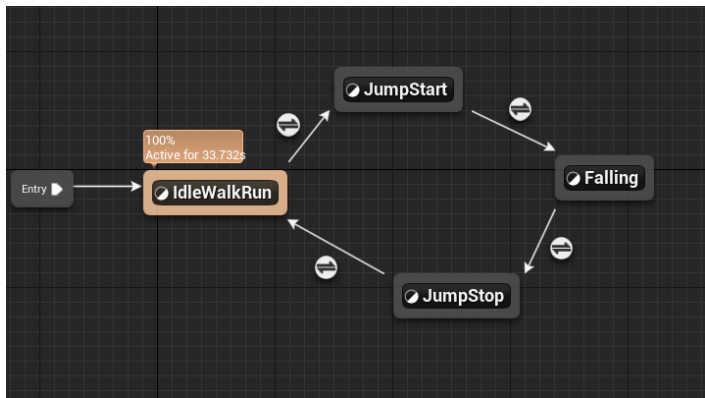


Fig.2. Unequipped State Machine

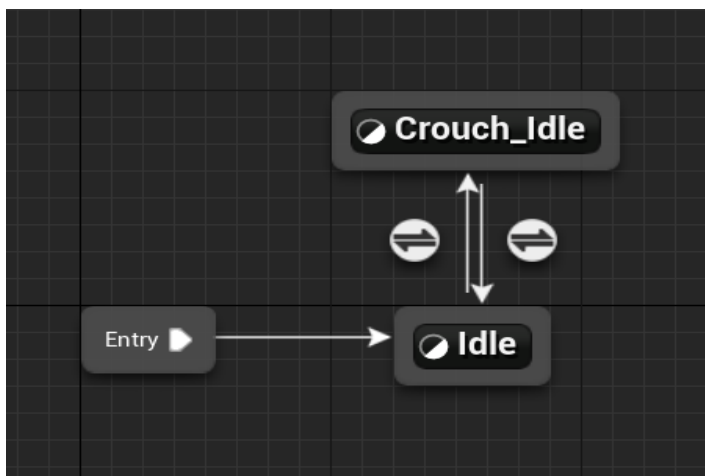


Fig.3. Equipped State Machine

D. Player Movement Input/Controls

We defined keyboard bindings for player movement using Action mappings. The Action mappings allow us to easily define and manage player input in the game. We have actions like jump, equipping the weapon, crouches, and aim, and we've bound specific keys to each of those actions. Using the axis mappings we have mapped the actions such as MoveForward, MoveRight, Turn and LookUp. Axis mappings allow for continuous input, meaning that the input is not just a single button press but a range of values that can be used to control the game.

E. Shooting

The player can shoot by using the left mouse button, and they can target specific opponents by clicking the right mouse button. As soon as the game begins, we spawn the weapons on a fixed location in the level of the game. Using the fire weapon montage we are implementing the firing animations. A fire weapon montage in Unreal Engine is a type of animation montage that is used to play a sequence of animations when the player fires a weapon. In BP Weapon, the animations have been implemented. The firing animation plays whenever the player pushes the fire button, and a projectile is fired from the weapon. As the game mode is multiplayer, all of the clients see the same animations.

F. Heads Up Display(HUD)

The HUD is a graphical interface that displays important information to the player during gameplay, typically overlaid on the screen or at the edges of the screen. The HUD can display a wide variety of information depending on the game. Following are the details that our game would display

Health:

The player character has a health of 100 points and the opponents would also have the same amount of health. Each weapon does different amounts of damage based upon the weapon type. Health can be replenished by walking over the health pickups that spawn randomly over the map.

Power Ups

There are a variety of power ups that enhance the abilities of the player character for a limited period of time. Following are the different power ups available for the players.

1. Shield Pickup

Using this pickup, the player character can replenish the shield to the original amount which is 100. The shield provides the player extra protection against the opponents and ability to survive more throughout the game.

2. Speed Buffs

The speed buffs are the pickups that give the player temporary acceleration in the speed of running. By using the speed buffs, players can gain advantage of speed for a limited amount of time and try to eliminate the opponent.

3. Jump Buffs

The jump buffs are the pickups that give the player temporary the ability of jumping higher than usual jump. Players can use the power as an advantage against the opponent to achieve maximum score.

4. Ammo Pickups

If the ammo of any particular weapon is exhausted then

the player can walk over the ammo pickup in order to refill the ammo. Also if the player needs additional ammo then the player can use ammo pickups to increase the ammo the player is carrying.

Timer:

Once the player lands into the main map, the timer starts. The time is limited and the goal of the player is to achieve maximum eliminations in the game. After the timer ends the player is navigated to the main menu and player can again start the game using the buttons.

G. Game Modes

In multiplayer shooting games, game modes are different variations of gameplay that offer unique objectives and challenges for players to complete. There are several game modes that add variety into the gameplay and allow players to experience different play styles. We have incorporated mainly three game modes which are as follows:

Teams:

To play this game style, two teams—the red team and the blue team—must be formed. The player can select the color of their preferred team, and each team's objective is to eliminate as many opponents from the opposing team as they can. The winning team is revealed at the end of the game.

Capture the flag:

In this game style, flags are placed throughout the area, and the players' objective is to return the flags to their base before the opposing team steals them. The winning team is the one who successfully captures the most flags.

H. Lag Compensation

Lag compensation in Unreal Engine is a technique used to mitigate the effects of network latency in online multiplayer games. In online gaming, when a player performs an action, such as firing a weapon or moving their character, it takes time for that action to be transmitted over the network to the game server and then to be sent back to other players. This delay is known as network latency or lag. Without lag compensation, a player's actions would be delayed by their network latency, causing them to appear to other players as if they are playing in slow motion. This can make the game unplayable and frustrating for players with higher latency. We have implemented this feature in order to have smoother gameplay experience.

V. RESULTS

The objective of this project was to develop an online multiplayer shooter game using Unreal Engine 5 for the purpose of fun. The game was tested on multiple machines in order to collect feedbacks and identify scope for improvement. The game was tested on steam platform. Different game modes such as "Capture the flag", "Teams". The results showed that the game performed well with no major technical issues or glitches. The game performed well in terms of technical performance, with an average frame rate of 60 frames per second and an average latency of 30 milliseconds. Testers reported a high level of engagement and enjoyment while playing the game. Further analysis of the results revealed that the most popular weapons among participants were the assault rifle and the shotgun. Participants found these weapons to be effective in a variety of situations and easy to use, contributing to the game's overall enjoyment. Testers reported that the

gameplay mechanics were well-balanced and challenging, requiring strategy and teamwork to succeed. The map design was also praised for its intricate layout and ability to facilitate different playstyles. In addition, testers provided feedback on various aspects of the game, such as graphics, sound, controls, and gameplay mechanics. The majority of testers rated the graphics and sound as excellent, while some testers expressed some difficulty with the controls and suggested improvements to the gameplay mechanics.

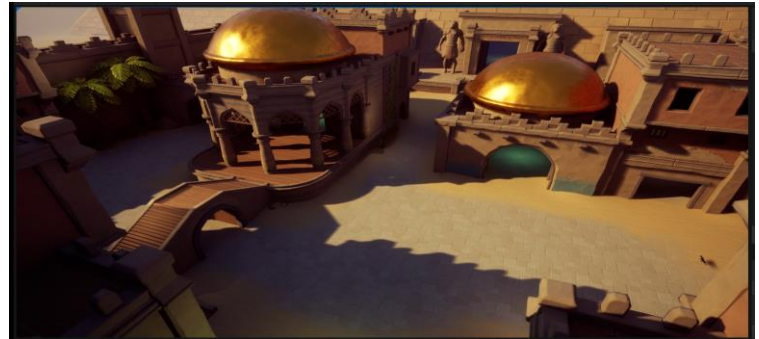


Fig.4. Main Map for Gameplay

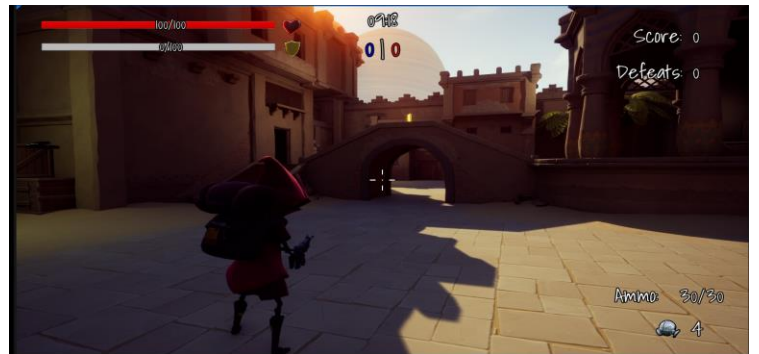


Fig.5. Teams Game Mode

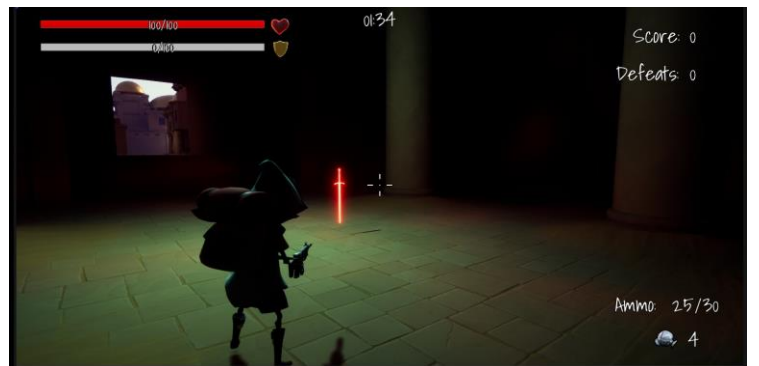


Fig.6. Capture the Flag Game Mode

VI. CONCLUSION

In conclusion, online multiplayer shooter games have become increasingly popular in recent years, offering players an immersive and competitive experience. These games allow players to team up with friends or strangers from all around the

world to battle it out in fast-paced action-packed environments. With the advancement of technology, the graphics and gameplay have become more realistic, providing a more engaging and satisfying experience. However, like any online game, there are concerns around safety, addiction, and social issues. Players should always be aware of these potential risks and take appropriate measures to protect themselves. Our project built a fully functional multiplayer game with crucial features that enhance the overall gameplay experience of the player. Features such as lag compensation, different game modes and the option to create own sessions provides privacy while playing over the internet. Players can easily connect and play with each other by simply a click of a button. Online multiplayer shooter games can be a fun and exciting way to spend time with friends, improve your skills, and challenge yourself against other players. Overall, online multiplayer shooter games offer a thrilling and competitive experience that appeals to a broad range of players. While there are potential risks involved, players can take steps to stay safe and enjoy these games to the fullest.

VII. FUTURE SCOPE

Our multiplayer game can be further implemented into various trending fields such as Virtual Reality technology that has the potential to revolutionize online multiplayer shooter games. VR technology allows players to feel like they are actually in the game, creating a sense of presence that is not possible with traditional gaming platforms. This enhanced immersion can make the gameplay experience more intense and satisfying. Also our game can be exposed to cross platform play. Cross-platform play makes it easier for players to find opponents and create larger gaming communities, as players on different devices can play against each other. This can help create a more diverse player base, allowing players to connect with others from around the world.

REFERENCES

- [1]<https://www.gamesindustry.biz/shooter-genre-sees-largest-engagem-ent-growth-on-pc-in-the-midst-of-social-isolation>
- [2]<https://blog.roundhillinvestments.com/exploring-the-growth-of-gam-e-engines>
- [3]<https://www.unrealengine.com/en-US/blog/unreal-engine-5-offers-si-gnificant-new-potential-for-the-simulation-industry>
- [4]<https://docs.unrealengine.com/4.26/en-US/InteractiveExperiences/Networking/Actors/RPCs>
- [5]https://developer.valvesoftware.com/wiki/Latency_Compensating_Methods_in_Client/Server_In-game_Protocol_Design_and_Optimization
- [6]<https://dl.acm.org/doi/10.1145/3204949.3204971>
- [7]<https://dl.acm.org/doi/10.1145/3440840.3440857>
- [8]<https://airconline.com/csit/abstract/v12n13/csit121310.html>
- [9]<https://www.unrealengine.com/marketplace/en-US/product/stylized-egypt>