ElevateVR Drone Simulator

An Affordable First Person View Drone Simulator

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ABSTRACT

The ElevateVR Drone Simulator is a virtual reality project designed to deliver an immersive and realistic FPV (First-Person View) drone experience, offering accessible alternatives to costly and high-risk real-world drone racing. This simulator features three distinct modes: racing, time trials, and freeplay, each designed to provide a unique and engaging playstyle. Players can explore custom-designed environments with interactive objects and obstacles.

Built using Unity[11] and Unity's physics engine[12], the project focuses on simulating realistic drone dynamics, including gravity, drag, and wind resistance. The racing mode features AI competitors, while the time trial mode focuses on precision and speed, both through a racetrack with custom layouts. The freeplay mode allows players to explore maps at their leisure, offering opportunities to practice skills or simply enjoy the environments. Custom objects and maps, developed specifically for this simulator, enhance immersion and provide creative challenges tailored to each mode.

The development process prioritized responsive controls, mechanics, and stable performance across all playstyles. User testing ensured the realism of flight mechanics, intuitive controls, and fun gameplay. Success is measured by the simulator's ability to offer distinct, polished modes of play, realistic FPV visuals, and reliable technical functionality. ElevateVR demonstrates the potential for VR technology to deliver an authentic FPV drone experience while giving users accessible tools for practice and entertainment without having to worry about a financial burden.

1 Introduction

The realm of FPV drones has gained popularity in recent years, because of both the fun of using and controlling a drone, with the technical skill and creativity of customizing or creating drones. Existing both in real life with physical drones as well as the creation of online drone experiences, the realm of FPV drones is massive. However, the financial and physical risks associated with traditional FPV drones, both digital and physical, is a massive barrier for newcomers. High-quality drones or drone simulators often cost over $600, and crashes with real life drones, which are common during the learning process, can result in extensive damage and costly repairs. These obstacles discourage many people from engaging with the hobby, despite its appeal. Recognizing these challenges, the ElevateVR Drone Simulator project was created to provide an accessible, immersive, and authentic FPV experience in virtual reality, removing the cost and risk factors while preserving the excitement and fun of drone flight.

The lack of affordable, high-quality FPV drone simulators in the market is a big reason for the importance of this project. While a few VR-based drone simulators exist, they fail to capture the true FPV effect – missing elements like realistic flight dynamics, intuitive controls, and the immersive visuals that define the real-world experience. Most of these simulators as well focus on other vehicle types, such as larger plane shaped drones. These limitations are an opportunity to design a simulator that not only replicates the physical mechanics of drone flight but also introduces many playstyles, such as racing, time trials, and freeplay. Each mode caters to different user preferences: racing emphasizes competitive gameplay with AI opponents, time trials focus on precision and speed, and freeplay provides a sandbox for exploration and skill development. The inclusion of custom-designed environments, objects, and dynamic challenges gives an engaging and tailored experience for users.

Beyond addressing financial and technical barriers, this project shows the potential of VR technology to create fun educational experiences. By simulating realistic drone physics, designing environments, and incorporating many play modes, the ElevateVR Drone Simulator delivers a comprehensive platform for users to practice skills, explore new challenges, and enjoy the appeal of FPV flight. Additionally, this project highlights the educational value of such simulations, offering users the opportunity to improve their hand-eye coordination, spatial awareness, and problem-solving abilities in a risk-free environment. By lowering the entry barriers to drone racing, the ElevateVR Drone Simulator aspires to make the exciting world of FPV drones more inclusive and accessible to all, giving both fun and personal growth to all players.

2 Related Work

2.1 Other Drone VR Simulators

Research on drone simulation and control has grown significantly in recent years, as drones are increasingly deployed across fields such as agriculture, construction, and entertainment. Among the challenges in drone operation are signal loss and crash prevention, especially in urban environments where obstacles like buildings harm drone navigation. To address these issues, various simulation tools and frameworks have been developed. For instance, DJI has created flight simulators to help operators familiarize themselves with drone controls; however, these simulators often lack realistic scenarios involving complex urban landscapes or real-world environmental data. Other studies, such as Paterson et al.'s work[5], leveraged Unity3D to create VR environments for path planning, showing improvements in safety and usability over manual control. However, these approaches largely focus on virtualized or generic environments rather than incorporating real-world data.

DroneVR[1] created by Nguyen et al. stands out by integrating real-world map data from OpenStreetMap into a virtual reality simulator. This approach enhances realism and operator preparedness by allowing users to practice in environments mirroring actual locations. Additionally, DroneVR addresses cost-related concerns by focusing on affordable drones without advanced sensors. Previous work, such as Crescenzio et al.'s[6] touch screen interface, gave insights into UAV control in 3D environments but lacked immersive interaction. DroneVR advances this area by combining real-world map data with web-based VR accessibility, allowing for a broader audience of drone operators to safely train in complex environments while avoiding crash risks and object tracking limitations in low-cost UAVs.

The work presented in DroneVR directly informs our project, as it highlights the challenges and opportunities in developing virtual reality simulations for drone operations. Specifically, DroneVR emphasizes the importance of realistic simulations for training drone operators in path planning, navigation, and crash avoidance, especially in complex environments like urban areas. These goals align closely with the objectives of our project, which also seeks to deliver an immersive VR-based drone simulator to enhance operator proficiency and reduce real-world risks. Also the Unity3D pathfinding elements implemented within DroneVR was a direct inspiration for our basic AI in racing, as it created a path the AI drones could follow to attempt to complete the track in the shortest amount of time.

Finally, the user studies conducted in DroneVR offer a framework for how we evaluate ease of use and effectiveness. Incorporating feedback mechanisms into our project, and asking similar questions gives us a higher likelihood that the final simulator meets the needs of both novice and experienced drone operators, which is a core reason for our project. Overall, DroneVR establishes a clear precedent for leveraging VR to address challenges in UAV operation, directly inspiring and validating the objectives of our project.

2.2 FPV Pilot User Experience

There are many different usages and ways to use an FPV drone for entertainment, industry, or security purposes. However, owners of the technology usually focus on one or two specific ways to pilot and use the drone, and they often seek models specialized in their particular interests. In ElevateVR, we aim to attract the commercial entertainment market of users, which requires a thorough understanding of their preferences and needs. A comprehensive foundation for this is provided by the work of Tezza et al.[2], who surveyed 515 FPV pilots to understand their equipment preferences, flying styles, motivations, and the broader FPV culture.

Tezza et al.'s[2] findings highlight the popularity of freestyle and racing among FPV pilots, with many citing the thrill of navigating high-speed courses or performing intricate aerial stunts as key motivations. The analysis shows that 43.08% of them fly freestyle only, 8.33% fly only for racing purposes, and 48.57% fly both racing and freestyle. These styles rely heavily on the acrobatic (acro) flight mode, known for its unrestricted control and precision. This preference aligns closely with the goals of ElevateVR, as our simulator seeks to replicate the responsive nature of acro flight. While this mode's steep learning curve can be scary for a beginner, it is also a source of fun and engagement, particularly for those seeking to master FPV flying. ElevateVR can address this by giving them a risk free environment to test in, providing an accessible entry point for beginners while offering depth and challenges for experienced pilots.

Another key aspect explored by Tezza et al.[2] is the overlap between FPV piloting and gaming. A significant portion of surveyed pilots reported backgrounds in video games or remote-controlled (RC) hobbies, which influence their comfort with FPV controls and their flight preferences. For ElevateVR, this overlap shows the importance of intuitive controller mappings. This shows that FPV drone pilots are more likely to learn better from a simulator, and also be more likely to use one in the first place. The FPV community's strong social media presence, with over 89% of pilots sharing flight footage online, suggests additional opportunities for ElevateVR. Features that allow users to record or share their virtual flights could replicate the creative and social dimensions of FPV piloting, which works great with a virtual reality experience. Moreover, the growing interest in FPV sports competitions, particularly for racers, indicates that competitive modes or virtual racing leagues could attract a broader audience.

The findings also touch on the therapeutic potential of FPV flying, with evidence that repeated exposure to heights through FPV can reduce acrophobia. While not a primary focus for ElevateVR, this insight highlights the immersive and impactful nature of FPV experiences, suggesting that our simulator could have applications beyond entertainment, such as training or therapy.

By leveraging the detailed insights provided, ElevateVR can position itself as an authentic and engaging FPV drone simulator tailored to entertainment. From intuitive controls to exploring and competitive features, our design can draw from different preferences of the FPV pilot community, creating a platform for both enthusiasts and newcomers alike.

2.3 Mixed-Reality Environments for FPV Drone Flying

The field of drone simulation and control has seen significant advancements in leveraging virtual, augmented, and mixed reality technologies to enhance user experience and training capabilities. A notable contribution to this domain is the study by Kim et al.[3], which presents an Aerial Mixed-Reality (MR) Environment for FPV drone Flying. The system integrates stereo cameras and head-mounted displays (HMDs) to create immersive and interactive environments that combine real and virtual elements. This approach allows users to fly drones with enhanced depth perception and improved situational awareness, critical for both novice and experienced pilots. The study highlights the importance of using MR to increase immersion, reduce collision risks, and enable dynamic interactions between physical and virtual spaces.

Through a series of user studies, Kim et al.[3] showed that their MR environment offers superior immersion compared to traditional VR-based drone simulators, particularly in obstacle avoidance and depth estimation tasks. Their work shows the potential of MR in creating cost-effective and engaging environments for FPV drone training, with applications ranging from drone racing to professional training.

The ElevateVR Drone Simulator builds upon such advancements by incorporating Unity's physics engine[12] and integrating key elements like drone physics, cybersickness reduction, and map design. While Kim et al.’s study focuses on real-world MR environments, ElevateVR aims to address the gap in accessible, high-fidelity FPV simulators by simulating these environments entirely within VR. This approach aligns with Kim et al.’s[3] findings on the importance of immersion and depth perception, while aiming to deliver these benefits in a purely virtual setting, reducing hardware constraints and enhancing accessibility for broader audiences.

In summary, ElevateVR draws inspiration from the principles and findings of studies like Kim et al. 's[3], adapting and extending them into a virtual-only simulation context, with the added goal of affordability and ease of use. This makes sure that both novice and experienced users can experience realistic FPV scenarios, further bridging the gap between virtual training and real-world FPV drone operation.

3 Project Description

Upon launching the ElevateVR Drone Simulator, users are greeted with a menu interface that acts as the opening and switching between gameplay modes. We use the default Unity UI design, and attempted to make it as clean and functional, providing five primary options prominently displayed on the screen: Racing, Freeplay, Time Trial, Controls, and Settings. These options are the entry points to various game modes and settings, allowing users to quickly navigate to their desired experience. In the background, a green forest scenery[10] is visible. While not the focal point, this backdrop adds subtle depth and atmosphere. It also can act as a checkpoint for avoiding cybersickness from some of the other high speed modes.

When selecting any of the gameplay modes, such as Racing, Freeplay, or Time Trial, users are brought to a secondary screen that enables map selection. The simulator offers two distinct environments: a cityscape and a racetrack. The city map[9] is an urban setting filled with tall buildings, narrow alleyways, and obstacles, providing a more crowded challenge to users. In contrast, the racetrack map[10] delivers a fast-paced course designed for competitive play, and is also the more default option for the racing and time trial options. This variety ensures players can tailor their experience, whether they seek relaxed exploration or competition.

The Controls option directs users to a tutorial designed to familiarize them with the game's control scheme and mechanics. The tutorial screen, which can be seen in Figure 1b, displays a pair of Meta Quest controllers alongside visual labels explaining the primary controls. The left stick manages throttle and yaw, allowing players to adjust altitude and rotate the drone, while the right stick controls pitch and roll, enabling forward, backward, and lateral movements. The X button on the left controller is dedicated to the respawn function, giving players a quick way to recover from crashes, and the pause button is easily accessible from its default position of pause on the left controller.

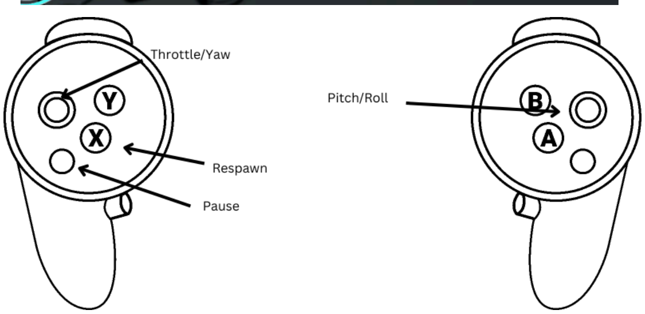


Figure 1: **1a (top): Picture of the 6 drone models[7] used for both the AI and the player. 1b (middle): The tutorial shown in game when clicking the "Controls" button in the main menu. 1c (bottom): The settings screen with variable options for drone customization.**

When starting the game in whatever gamemode is desired, a 3D model of the drone[7] itself (Seen in Fig. 1a) will be visible. This model includes animated spinning rotor blades and is designed to rotate subtly in response to user input. The front half of the drone is displayed while playing the game, helping users understand its orientation and build a connection between their actions and the drone's movements. This increases the presence in the simulator, making the users potentially less cybersick, while also preserving the realism that the simulator is trying to achieve.

Finally, the main menu also contains a settings option (seen in Fig. 1c). This allows the user to manually adjust and customize the drone movement to be able to fully understand how the drone works. This can be used to emulate real world drones, or just create a more thrilling experience. First of all the turn sensitivities can be adjusted for all four directions, which will make the drone turn faster in the specified direction. Then, there are the right and left deadzone settings, this adjusts the area around the center of the joystick where small inputs are not registered. This helps with preventing motor drift, as well as other small errors in movement. Finally, there is also the max speed setting, which allows the user to go slower or faster, although the acceleration remains the same. This can help users who get cybersick with fast movements, while also allowing users who are used to FPV drone racing to get a more engaging experience. To facilitate this further, we have three different options for presets people can choose. These presets are "Beginner" the default and basic option for people new to FPV drones, "Expert" for experienced pilots, and "Advanced" for people in between.

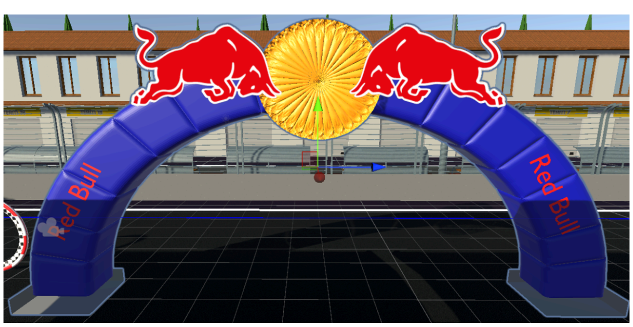
3.1 Racing

The racing mode in ElevateVR is a fast-paced, competitive experience that replicates existing drone races in the real world. This mode is designed to balance precision while also being user accessible as racing is a topic many people are familiar with or have seen before in gaming. We attempt to offer a realistic and engaging drone racing experience while addressing challenges with high speeds like cybersickness. This section outlines the core features of the racing mode, their implementation details, and the design considerations that enhance usability and immersion.

3.1.1 **Racetrack Map and Navigation System**

The racetrack consists of a pre-designed map[10] containing several checkpoints and a final lap gate that players must navigate through in sequence. Each checkpoint and the final gate are represented by custom-built 3D models created in Blender[13]. These models (Seen in Figure 2) were crafted to be visually distinct, making sure they are easily identifiable within the virtual environment. They also emulate existing racing items, such as the redbull gate from F1 (Formula-1), to give users a more familiar feeling while racing. The City map[9] is more of a challenge made for experienced FPV drone pilots, with a large amount of obstacles to dodge through. Both maps use the same checkpoint and lap gate, with the same logic attached. The checkpoints are placed to guide players through the racetrack while allowing flexibility for advanced players to optimize their routes between them. The lap gate, which looks distinctly different from checkpoints, serves as both a starting and ending point for each lap.

To assist players in navigating the course, a dynamic arrow points toward the next checkpoint or the final gate, depending on the player's position in the race. This navigation aid uses Unity3D's vector math to calculate the direction from the drone's current position to the target checkpoint, providing guidance to the user if they get stuck or confused. The arrow's behavior is updated in real-time to accommodate fast-paced movement and changing positions on the track.



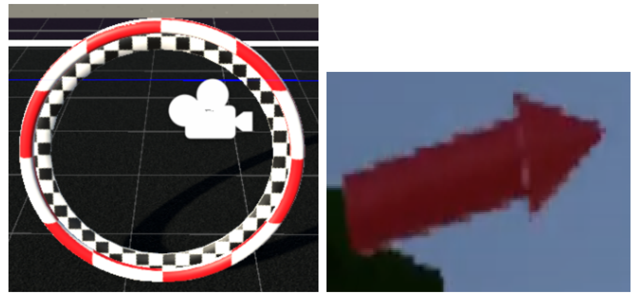


Figure 2: **Custom-designed checkpoints and lap gate on the racetrack, made to emulate real life checkpoint hoops and the Red Bull lap gate. The directional arrow points to the nearest checkpoint, or if there are no more checkpoints, it points to the lap gate.**

3.1.2 **AI Opponents**

To create a competitive environment, the racing mode includes simplistic AI-controlled drones that participate in the race. These AI drones use Unity3D's vector math system to compute the shortest path through the racetrack. This shortest path is then augmented with randomness for travel speed and direction, adding replayability to the races. The AI drones travel the same speed as the player drone, matching the speed set in the settings menu. Each checkpoint is registered as a waypoint, and the AI navigates sequentially from one to the next, in a random but efficient manner.

The AI was configured to replicate basic drone behaviors, such as smooth turns and speed adjustments when approaching checkpoints. It also uses the same drone model[7] as the player, however they have different colors and names. While the AI is simplistic, it provides a challenging baseline, especially when multiple AI drones compete simultaneously.

3.1.3 **Position Tracking System and Leaderboard**

The position tracking system calculates and updates the player's rank in real-time during the race as well as after the race is completed (As seen in Fig. 3). Players are ranked first by the number of laps completed. If multiple players have completed the same number of laps, the number of checkpoints reached is used to rank them. If players are tied in both laps and checkpoints, the distance to the next checkpoint or lap gate resolves the tie. The distance is measured as the Euclidean distance to the next checkpoint or lap gate where (x1,y1,z1) are the player's current coordinates and (x2,y2,z2) are the target checkpoint's coordinates.

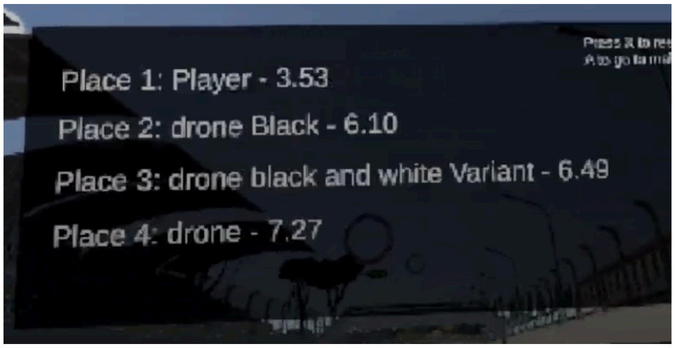


Figure 3: **Leaderboard displaying the players within the race. In this case there are four players in a one lap race. The player placed first in a time of 3.53 minutes, with the second place finishing in 6.1 minutes.**

3.1.4 **Cybersickness Mitigation**

Cybersickness is a common challenge in VR experiences involving fast movement. To lower the amount of sickness while playing, the racing mode uses several techniques. First of all we used a high field of view (FOV). A wider FOV reduces perceived motion intensity, minimizing discomfort. This feature is implemented by adjusting Unity's Camera component settings during gameplay. We also added very slight motion blur and vignette effects that would not overwhelm the user, but also help them with presence. These visual effects are applied during acceleration or sharp turns to provide cues that align with the player's actual vision. When testing, we focused on turns especially as it seemed to be the place where users would get the most sick. To help with this we also implemented dynamic speed scaling, where the drone's speed is slightly reduced during sharp turns to decrease the abruptness of motion. Finally, we also decided on keeping certain HUD elements stable on the screen to help with too much movement on screens. The navigation arrow in particular is designed to remain steady, which reduces the amount of visual distractions. These techniques were tested iteratively, with adjustments based on our personal feeling while testing, and user feedback from playtesting near the end of development.

3.2 Time Trial

The time trials mode in ElevateVR offers players more of a solo challenge, focusing entirely on speed. Using the same racetrack map, checkpoints, and lap gate as the racing mode, this mode shifts from competitive to individual performance. Players go through the course, aiming to complete laps and checkpoints in the shortest possible time.

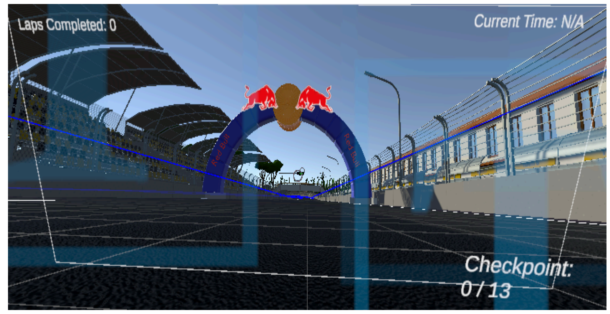


Figure 4: **Photo of the UI shown to the player when accessing the "Time trial" mode of the game. Laps completed show on the top left, which increase whenever the user passes the Red Bull lap gate. Current time in the top right is a collective time counted in seconds that begins ticking up when the user passes the first lap gate. The bottom right shows the checkpoints that have been passed during the race, which are scattered across the track.**

In time trials, the primary metric is the player's speed. The system accurately times the completion of each lap, as well as individual checkpoint intervals, allowing players to track their performance. This data is displayed on screen in real-time, giving players immediate feedback on their progress and pace (Seen in Fig. 4). We used built in Unity time measurements to make sure it records precisely, and logs the times correctly. These times are updated during gameplay and stored for later review, allowing users to improve by retrying multiple times.

During time trials, there are no AI competitors creating a more solitary, but focused gameplay loop where players can get better at racing without extra distractions. The time trials mode retains the same cybersickness mitigation techniques employed in the racing mode, attempting to make a more comfortable experience during gameplay. High field of view (FOV), motion blur adjustments, and stabilized visual elements reduce discomfort during intense or high-speed segments. These measures, combined with the slower paced nature of time trials, make it a welcoming environment for players new to drone racing, or those who simply want to test out different methods of movement and speed.

3.3 Freeplay

The freeplay mode in ElevateVR offers an open-ended, exploration experience that serves as a sandbox for players to get used to different drone piloting skills and immerse themselves in different environments. Unlike the structured challenges of racing or time trials, this mode removes any objectives, focusing instead on the freedom to explore and experiment with the drone's mechanics at the player's own pace.

Freeplay mode has two distinct maps, each crafted to provide a unique environment and set of challenges. The first map is a large cityscape[9], which has a range of urban elements such as skyscrapers, streets, and parks (Seen in Fig. 5). This setting allows players to practice navigating between spaces and maneuvering around large structures, which uses the same spatial awareness required for real-life FPV drone operation. By learning to anticipate and avoid obstacles, players gain valuable experience that translates directly to real-world drone piloting. Additionally, the urban map is an experience that is not possible with real FPV drones due to flight regulations in populated areas, so it gives players an opportunity to explore cityscapes from a bird's-eye view.

The second map is the classic race track map[10], but this time without any checkpoints or timing. This allows people to explore the map without being forced to stay on the track. It also can allow people to view the race track before racing, or continuously practice the same route on the race track without being timed or having to navigate through the entire track. The map is a race track in a wooded area, which is a great complement to the city because it is an environment focused on more of an open flight area rather than a restricted one. Together, these maps provide a balanced set of opportunities for both beginners and advanced players to practice and improve their flying skills.

Freeplay mode is particularly valuable as a training ground for new drone pilots. The absence of objectives creates a low-pressure environment where players can focus solely on becoming familiar with the drone's controls, physics, and dynamics. Unity's Physics Engine[12] is important in this mode, attempting to accurately simulate the drone's flight characteristics, including acceleration, deceleration, and the subtle effects of gravity. While this is present in the other gameplay modes of ElevateVR, it is especially noticeable in the more tame version of just exploring.

The mode also emphasizes exploration. Players are encouraged to discover details within the maps, such as architectural designs in the city or overlooks in the open landscape. These elements enhance the sense of immersion, making freeplay mode engaging and educational. Also, this exploration with moments to slow down, view scenery, and try new things provide a moment to relax from cybersickness, while still getting the benefits from playing the game itself. Overall, freeplay mode is an important part of ElevateVR by offering an unrestricted opportunity for exploration and practice. This mode ensures that the simulator appeals to both recreational users and aspiring drone pilots alike.

Figure 5: **Picture of the City Map[9] mode from the drone's view when looking down a street. This also hides the drone model from the screen to show a more cinematic view.**

4 Assessment

ElevateVR turned out to be a great proof of concept for a VR-based FPV drone experience, showing the potential of virtual reality to provide a realistic and engaging platform for both recreation and skill development. The project successfully implemented several features, including three different gameplay modes, realistic physics, and initial cybersickness mitigation measures, showing how the physical drone experience can be translated into a VR simulator. Despite the limitations posed by a short development timeline, the project achieved its primary goals and laid a good foundation for further expansion.

One of the project's biggest achievements was the integration of three distinct gameplay modes: racing, time trials, and freeplay. These modes provided users with various ways to enjoy the simulator, from competitive high-speed challenges to exploration that allowed them to freely navigate the environment and practice their piloting skills. This versatility added replayability and made sure that the simulator could cater to different user preferences, making it enjoyable for both casual users and those seeking to hone their FPV drone skills. The implementation of these modes, supported by custom 3D objects and imported maps, created an engaging experience that allowed players to interact with their environment in meaningful ways.

Realistic flight mechanics, including physics elements such as drag and gravity, were another major accomplishment. These features contributed to the authenticity of the drone simulation, giving users a sense of what real FPV piloting feels like. The movement mechanics were carefully adjusted to ensure smoother control, improving both the immersion and usability. The addition of settings to adjust these variables allowed for users to emulate drones they have in real life, or test out what sort of drone they would want in the future. This was further supported by feedback gathered from a small amount of user tests. Testers reported enjoying the simulator, particularly the varied modes and realistic controls, despite some experiencing mild cybersickness. Their feedback validated the core gameplay experience we were going for, while also outlining some areas for future improvement.

In addition to its technical achievements, the project showed a thought out approach to the user experience. Tutorials were designed to help new players get accustomed to the controls, while efforts were made to optimize layouts and improve performance. Initial steps to mitigate cybersickness, such as adjustments to the field of view and motion intensity, reduced the initial sickness people would get when trying the drone experience for the first time. These measures, while effective to an extent, could be further developed in future iterations to ensure comfort for a broader range of users.

Overall, the ElevateVR Drone Simulator succeeded in delivering an engaging and realistic FPV drone experience, complete with multiple gameplay modes and clean movement. While there is room for growth, the positive feedback from testers and the strong base gameplay established by this project highlight its potential to become a fully featured and versatile drone simulator in future iterations. By working on and removing its limitations and incorporating user suggestions, the project could evolve into a standout offering in the VR gaming landscape.

5 Future Work

While we believe that ElevateVR successfully fulfills the primary objectives with an FPV drone experience with diverse playstyles, the project faced several limitations due to time constraints. As a result, certain features remain underdeveloped or not created at all, leaving a lot of room for future enhancements. Key areas for improvement include map variety, AI improvements, cybersickness mitigation, drone customization, multiplayer, database usage, and expanding gameplay options to increase engagement and depth.

The simulator currently offers a limited selection of maps, restricting the variety of environments and challenges available to players. Expanding the library to include diverse settings such as dense forests, canyons, or futuristic areas would allow for more gameplay experiences. Also, integrating environmental elements like weather conditions, moving objects, or different times of day effects could further enhance immersion and increase the challenge for users.

Although basic cybersickness avoidance techniques, like motion smoothing and field of view adjustments, were implemented, more advanced solutions could be implemented to help users. Techniques like dynamic camera stabilization could refine the simulator to reduce the amount of sickness users can get. Also, including optional haptic feedback through VR controllers could provide better immersion and help ground players during movement.

The racing AI, while functional, is basic and could benefit from more advanced algorithms. Adaptive AI that is able to react to player actions or employ different strategies would create a more competitive and engaging experience. Also, introducing a multiplayer mode, either locally or online, would allow players to race against friends or other users, adding a social piece to the gameplay.

Drone customization is another area for expansion. While there is a settings menu to control different aspects of how the drone moves, there is currently no way to change the look of the drone itself. Future versions could include adjustable aesthetic customization like colors and decals. These options would allow users to create and experiment with drones that fit their unique preferences and also allow users to emulate physical drones they have in real life.

The addition of multiplayer would allow users to connect and compete with others in real-time, enhancing the social and competitive aspects of the simulator. Multiplayer functionality could include features such as customizable race modes, team competitions, and public or private lobbies to suit different player preferences.

Incorporating a robust database would further enhance the simulator's functionality by allowing users to save and share custom drone configurations, track records, and performance statistics. This addition could also support a marketplace for community-created drone designs, fostering creativity and collaboration among players.

Future iterations of the ElevateVR Drone Simulator have the potential to build on the current project by addressing these limitations and adding new features. With a longer development timeline, the simulator could improve itself into a realistic platform that is both an entertaining and educational FPV experience, appealing to casual players, hobbyists, and aspiring drone pilots alike.

6 Division of Labor

Aaron focused on creating 3D models for in-game objects, importing maps to design the environments, implementing the racing and time trial logic, and handling the initial integration of models such as the drone. He also imported and edited the two prebuilt maps that the game is based upon, doing extensive fixes with collision boxes to make sure it worked for flying objects. He also conducted extensive testing to make sure of the functionality of these features.

Evan concentrated on debugging and refining the gameplay experience by adjusting drone movement to feel smoother. He also worked on creating tutorials to guide players, improving performance within the simulator, and organizing and cleaning up the layouts of objects within the environments. Evan also organized a few people to test the simulator to find issues or verify features worked as intended, and adjusted based on feedback. Also, Evan was responsible for writing and structuring this technical research paper that documented the project's progress and outcomes.

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ASSETS USED

[7] Simple Drone by GameAnime:
https://assetstore.unity.com/packages/3d/vehicles/air/simple-drone-190684

[8] Race Car package by Ysn Studio:
https://assetstore.unity.com/packages/3d/vehicles/race-car-package-141690

[9] Demo City By Versatile Studio (Mobile Friendly) by Versatile Studio:
https://assetstore.unity.com/packages/3d/environments/urban/demo-city-by-versatile-studio-mobile-friendly-269772

[10] Cartoon Race Track - Oval by RCC Design:
https://assetstore.unity.com/packages/3d/environments/roadways/cartoon-race-track-oval-175061

SOFTWARE USED

[11] Unity: https://unity.com/

[12] Unity Physics Engine: https://unity.com/solutions/programming-physics

[13] Blender: https://www.blender.org/