CPG – 38

CAPSTONE PROJECT

REPORT

ON

VIRTUAL REALITY FLIGHT SIMULATOR

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COE, 7th SEMESTER

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ABSTRACT

This project presents a state-of-the-art and immersive Virtual Reality (VR) Flight Simulator that uses cutting-edge technologies to simulate the complexities of real-world flight within a virtual setting. The main game engine for the simulation is Unity, with C# being used for scripting, Blender being used for careful 3D modelling, and powerful physics simulation for unmatched realism.

Unity, an adaptable and potent game creation engine, is the fundamental basis of the VR Flight Simulator. Unity is the perfect platform for producing a smooth virtual reality experience since it offers an extensive foundation for developing visually stunning and engaging simulations. The simulator's functionalities are scripted using the C# programming language, which makes it possible to integrate complex features and maintain seamless communication between its numerous components. The use of Blender software for 3D modelling in the project places a strong emphasis on visual authenticity and realism. Using this extensive modelling tool, the VR Flight Simulator's overall visual aesthetics are improved by creating incredibly realistic and detailed aircraft, landscapes, and environmental features. Blender's incorporation into the development process guarantees that the 3D assets are optimised for VR performance in addition to being aesthetically pleasing.

A key component of the VR Flight Simulator that enhances authenticity and immersion is realistic flight mechanics. Technologies for physics simulation are used to simulate the intricacies of wind resistance, gravity, and aerodynamics, guaranteeing that the behaviour of the simulated aircraft is identical to that of its real-world equivalent. This focus on detail makes the overall experience more realistic and engaging for consumers, resulting in an engaging flight simulation.

A key component of the project is graphics rendering, which aims to provide a seamless and visually appealing experience. Blender's optimised asset designs combined with Unity's rendering power enable the production of breathtaking VR environment images. As users navigate through the virtual skies, the seamless integration of graphics rendering technology guarantees that they are immersed in a visually rich and captivating universe.

DECLARATION

We hereby declare that the design principles and working prototype model of the project entitled VR Flight Simulator is an authentic record of our own work carried out in the Computer Science and Engineering Department, TIET, Patiala, under the guidance of Dr. Ajay Kumar during 6th semester (2020).

Date: 18/12/2023

Project Title: Virtual Reality Flight Simulator		
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We are also thankful to Computer Science and Engineering Department, Head, Computer Science and Engineering Department, the entire faculty and staff of Computer Science and Engineering Department, and our team members who devoted their valuable time and helped us in all possible ways towards successful completion of this project. We thank all those who have contributed either directly or indirectly towards this project.

Lastly, we would also like to thank our families for their unyielding love and encouragement. They always wanted the best for us and we admire their determination and sacrifice.

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TABLE OF CONTENTS

LIST OF ABBREVIATIONS

VR	Virtual Reality
GUI	Graphical User Interface
FSTD	Flight Simulation Training Devices
FAA	Federal Aviation Administration
ISO	International Organization for Standardization
IEEE	Institute of Electrical and Electronics Engineers
DIS	Distributed Interactive Simulation
SDK	Software Development Kit
AR	Augment Reality
OLED	Organic light-emitting Diode
LCD	Liquid Crystal Display
AI	Artificial Intelligence

CHAPTER 1
INTRODUCTION

1.1 Overview

As the project lead for the VR flight simulator, we developed an immersive training solution that utilizes cutting-edge virtual reality technology. Our simulator, accessible across various platforms such as PC and standalone VR systems, offers a comprehensive scope for pilot training, entertainment, and skill development. The innovation lies in realistic cockpit interfaces, providing a cost-effective and accessible alternative to traditional simulators. VR flight simulator stands out by offering a highly realistic experience, overcoming the constraints of physical space and resources associated with traditional flight simulators. It redefines pilot training by combining advanced technology with unparalleled accessibility and affordability.

1.1.1 Problem Statement:

1. Inadequate aviation experience during the training phase of a pilot trainee due to insufficient industrial grade Aircraft Simulators.

2. Time-sharing utilization of industrial grade Aircraft Simulators leads to a lack of experience.

3. Need to supplement the inadequate experience with a VR Simulator.

4. VR Simulator can emulate a real simulator but can simulate basic and medium complexity drills. The necessity to provide a cost-efficient supplement to the actual industrial simulator.

5. Requirement for mobility while serving the training cause.

1.1.2 Goal:

1. Create an immersive Virtual Reality Flight Simulator leveraging Unity.

2. Develop a detailed cockpit view of Cessna-172 mirroring real-world layout, instrumentation, and controls.

3. Integrate a gaming pad for user-friendly control over the virtual aircraft.

4. Implement VR headset integration for an immersive 360-degree virtual environment.

5. Create various 3D models of airports and terrains around those airports.

6. Deliver an integrated environment using Unity for an immersive flight experience.

7. Simulate authentic flying scenarios, weather conditions, and dynamic components.
8. Make the simulator an effective instrument for aviation instruction and educational purposes.

1.2 Need Analysis

1. **Training and Skill Development:** One particularly exciting application of VR Flight Simulator is its integration into flight simulation, where enthusiasts and aspiring pilots can experience the thrill and challenges of flying within a controlled virtual realm. It aims at harnessing Virtual reality technology to solve the problem of inadequate aviation experience at the training phase of a pilot trainee due to lack of adequate numbers of industrial grade Aircraft Simulators.

2. **Cost Effective:** VR Flight Simulator will provide a better and cost-effective way for pilots to get trained. Traditional simulators require complex and costly motion systems, hydraulics, and expansive physical structures. VR flight simulators rely on VR headsets, gaming controllers, and standard PCs, which are significantly more affordable.

3. **Mobility:** Conventional Flight Simulators are not portable and hence limit the learning of a pilot due to it. By using a VR Flight simulator one can get to practice his flying skills in his free time at anywhere he wants to.

4. **Mitigate risk:** One of the biggest advantages of utilising flight simulation is the chance to practise handling dangerous and emergency circumstances while flying without any actual danger. You are allowed to make mistakes in a virtual flight that you might not be able to recover from in the "real world." You will learn how to prevent harmful events from occurring in the first place by using simulation to practise risk identification, evaluation, and mitigation. Overall, using a flight simulator is a great approach to practise handling emergencies in a low-stress setting.

5. **Immersive Entertainment**: VR flight simulators provide an engaging and exhilarating experience for aviation enthusiasts and gamers alike. Users can explore virtual skies, fly a variety of aircraft, and embark on exciting missions in breathtaking landscapes. This entertainment factor adds a recreational dimension to aviation experiences

1.3 Problem Definition and Scope

The Problem at hand is the requirement for a cutting-edge and immersive flight training and entertainment solution that fills the void between pricey full-motion flight simulators and conventional desktop flight simulators. While full-motion simulators are unaffordable for many training centres and hobbyists, traditional flight instruction techniques can be expensive and geographically constrained. Additionally, there is a need for an enjoyable flight experience for gamers and aviation aficionados who wish to fly and explore the sky. A Virtual Reality flight simulator is envisioned as a flexible solution to these problems that combines innovative technology, realistic training, accessibility etc.

The construction of a full virtual environment that provides lifelike flying instruction and entertainment experiences is included in the project's scope for a VR flight simulator. The following essential elements are part of this:

1. Create a visually appealing and engaging virtual environment that simulates a wide variety of environments, climates, and scenarios. Give people a 360-degree panoramic vision using VR technology to foster a sense of presence and engagement.
2. Create an authentic and thorough replica of the cockpit complete with interacting controls, switches, levers, and instruments. Users should get a realistic piloting experience thanks to the cockpit's replication of real-world aircraft.
3. User Interaction: Include logical and simple controls that let users engage with the plane, the cockpit, and the mission goals. support a range of input devices, such as gaming pads and VR motion controllers.
4. Features geared towards education: Offer individuals interested in learning about aviation education tutorials and learning tools. These materials could address emergency procedures, instrument flying, navigational skills, and flight concepts.
5. Design captivating tasks and challenges for entertainment reasons so that people may participate in exciting situations, exploration, and leisurely flying experiences.
6. Research and Innovation Platform: Provide a setting for experts in aviation to conduct studies on pilot behaviour, human-machine interaction, and the testing of cutting-edge technology.
7. Consider frequent upgrades to improve the simulator's features and content.

1.4 Assumptions and Constraints

Several presumptions and limits must be considered during the design and development of a virtual reality (VR) flight simulator. Here are some typical presumptions and restrictions to consider:

Assumptions:

1. **Hardware Availability:** Users will have access to VR equipment, including headsets, controllers, and possibly even motion tracking sensors. The simulator will need to accommodate a variety of VR hardware.

2. **Basic User Experience:** Users are accustomed to the fundamental VR interactions, such as utilising the VR controllers and moving around in a VR world.

3. **Simulation Accuracy:** Although the flight simulator strives to provide users a realistic flying experience, it may make some physics and aircraft behaviour assumptions.

4. **Variety of Aircraft:** A wide range of aircraft could be supported by the simulator, including tiny general aviation aircraft, large commercial jets, and perhaps even military aircraft.

5. **Education and amusement:** Pilots, aviation enthusiasts, and other people with an interest in flying can use the simulator as a training tool as well as for pleasure.

6. **Visual Realism:** The simulator makes an assumption regarding the visual realism, which includes accurate and finely detailed 3D models of the aircraft, airports, scenery, and weather conditions.

Constraints

1. **Motion Sickness:** Due to the sensory conflict between virtual movement and actual stillness, VR experiences can make some users feel queasy. This presents a challenge to minimise.

2. **Resources Needed for Development:** Creating a VR flight simulator takes a lot of time, as well as talented designers, developers, 3D artists, and testers.

3. **Development Resources:** The development of a VR flight simulator requires significant resources, including time, skilled developers, designers, 3D artists, and testers.

4. **Licensing and Data:** Data acquisition can be expensive and time-consuming, and accurate aircraft models and flight data may be subject to licencing limitations.

1.5 Standards

Advisory Notice 120-45B from the FAA: Guidelines for the assessment, certification, and licencing of flight simulation training devices (FSTDs) are provided in this advisory circular from the Federal Aviation Administration (FAA). While not concentrating on VR particularly, it describes the standards and specifications for flight simulators, which may be applicable to VR flight simulation.

Part-FCL EASA CS-FSTD(A) and AMC/GM: The European Aviation Safety Agency (EASA) has produced certification criteria for flight simulation training devices, including those pertaining to helicopters (CS-FSTD(H)) and fixed-wing aircraft (CSFSTD(A)). These specs lay out the technical parameters for FSTDs and can offer guidance to those creating VR flight simulators.

A universal standard for quality management systems is ISO 9001. It is not particular to VR flight simulators, but it may be used to make sure that the design, manufacture, and maintenance procedures for these simulators adhere to high standards.

Multi-player and networked VR flight simulators can benefit from the protocols provided by IEEE
1278, Distributed Interactive Simulation (DIS), which is a standard for distributed interactive simulation environments. Between various simulation components, it assures compatibility and communication.

Plans for Software Quality Assurance in accordance with IEEE 730.1 This standard outlines the conditions for developing a software quality assurance strategy in the event that the virtual reality flight simulator incorporates software development. For safety and effectiveness, it is imperative to employ high-quality software in VR simulators.

1.6 Objectives

1. **High Degree of Realism:** The proposed solution able to provide a close to actual flight experience.

2. **Mobility:** The VR Simulator is highly mobile and easy to carry.

3. **Cost Effective:** The Simulator must be highly affordable and provide a quality experience to the user.

4. **Real Aircraft Dynamics:** The simulator needs to map all the dynamics of a real Aircraft.

5. **Performance Measures:** The simulator needs to real-time time feedback to the user and hence provide a performance measure.

6. **Ease of Use:** The simulator needs to be easy to use and abstract the unnecessary from the user.

1.7 Methodology

Building a VR flight simulator involves several key steps and methodologies. Here is an overview of some of the main methodologies used:

1. **Conceptually designing the simulator:** This stage involves creating a conceptual design of the simulator, including the hardware and software components, the user interface, the virtual environment, and the flight dynamics model. This may involve selecting off-theshelf components or designing custom-made components.

2. **Develop the software:** This stage involves writing the code for the VR flight simulator, which may include creating the flight dynamics model, developing the virtual environment, and programming the user interface.

3. **Assemble the hardware:** This stage involves setting up the physical components of the VR flight simulator, such as the display screen, the control devices (such as joysticks, headset, and pedals), and the computer system.

4. **Test and refine the simulator:** This stage involves conducting user testing to evaluate the performance, usability, and realism of the VR flight simulator. Based on user feedback, the simulator may be refined and improved.

1.8 Project Outcomes

1. **Fully Operable VR Flight Simulation Software:** The primary deliverable is a fully working VR flying simulator programmed. This software should accurately reproduce the flight experience in a virtual reality setting, including the cockpit controls, flight dynamics, and visual depiction.

2. **3D Virtual Environments:** To provide an immersive flying experience, the project may create real-world 3D surroundings, including as airports, runways, landscapes, and weather conditions.

3. **Virtual Aircraft Models:** The project could involve the creation and integration of virtual model of aircraft, with accurate visual and functional representations of their real-world counterparts.

4. **User input and Iterative upgrades**: The project includes methods for users to register input, which can result in iterative updates and upgrades to improve the functionality and realism of the simulator.

1.9 Novelty of Work

An immersive and dynamic virtual environment that closely resembles the experience of real world flight, the initiative fundamentally redefines the training paradigm. With this cutting edge strategy, conventional training techniques are replaced with experiential learning platform that provides students with a previously unheard-of level of involvement.

The development of VR technology adds a new level of realism. The initiative painstakingly replicates cockpit surroundings, letting users interact with real controls and instruments to develop muscle memory and procedural familiarity. Due to the high level of realism, the training environment is immersive, allowing students to continuously practise manoeuvres and procedures while improving their skills without being constrained by actual aircraft operations.

Virtual reality flight simulators' interactive features add a previously unattainable component of experiential learning. Users can look around the virtual cockpit, check their instruments, and take in their surroundings, very much like they would do during a real flight. This practical interaction closes the gap between theory and practise by improving situational awareness and decision-making skills.

Another innovative feature of the project is its flexibility to be applied to various settings. With the ability to replicate different aircraft models and environments, VR flight simulators give students the chance to practise in a variety of airspaces and emergency situations. This versatility makes it feasible to provide a variety of training experiences that are challenging, if not impossible, to provide using conventional techniques.

CHAPTER 2
REQUIREMENT ANALYSIS

2.1 Literature Survey

For the best utilization of existing knowledge on the concept of VR systems used for simulations an extensive Literature Survey was conducted.

2.1.1 Related Work

1. **Prepar3D:** A platform for professional-grade simulation created by Lockheed Martin for instruction and training.

2. **X-Plane Pro:** A variation of X-Plane created for use in commercial training programs.

2.1.2 Research Findings for Existing Literature

1. Johnson and Morrison [1] investigated the usability and effectiveness of a VR flight simulator for training commercial airline pilots. The authors found that the simulator was generally well-received by the pilots and that it provided a realistic simulation of flight conditions.

2. Gaillard and Guillou [2] evaluated the effectiveness of a VR flight simulator in training military pilots. The authors found that the simulator was effective in training pilots on basic flight skills.
3. Wright, Endsley and Kraiger [3] investigated the incidence and causes of simulator sickness in VR flight simulators. The authors found that simulator sickness was a common problem and that it was primarily caused by conflicts between visual and vestibular sensory input.

4. Lintern and Matthews [4] evaluated the effectiveness of a VR flight simulator for training military pilots. The authors found that the simulator improved flight safety and reduced the number of accidents.

5. Walker [5] reviewed 31 studies on the effectiveness of VR flight simulators for pilot training. The authors found that VR simulators were generally effective for training, and that they had several advantages over traditional training methods, including cost savings and increased safety.

2.1.3 Detailed Problem Analysis

1. **High Hardware Requirements:** To function properly with high graphics settings, many contemporary flight simulators require powerful hardware. This may restrict accessibility for those using less sophisticated hardware.

2. **Realism:** Realistic images, accurate physics simulations, and respectable performance might be difficult to balance in a positive way. Users desire a simulator that is realistic and fluid.

3. **Lack of Accessibility:** Because of their sometimes-sharp learning curves, flight simulators are less accessible to newcomers and recreational players.

4. **Expensive Add-Ons:** High-quality aircraft models, scenery, and other add-ons can be expensive, potentially creating a financial barrier for users who want a comprehensive experience.

2.1.4 Survey of Tools and Technologies Used

For use on a variety of platforms, including desktop, mobile, console, and virtual reality (VR), developers may create dynamic and immersive experiences using the Unity game engine and development platform. It offers an intuitive user interface, a visual scripting system, and a strong programming environment for developing games, simulations, architectural visualizations, and other types of content.

Unity IDE

Key characteristics and facets of Unity:

1. **Cross-Platform Development:** Because Unity enables building projects for numerous platforms, developers may produce content that works on various devices without having to completely rewrite the code.

2. **Asset Store:** The Asset Store offered by Unity is a marketplace where programmers may find pre-made assets, scripts, tools, and plugins to improve their works.

3. **Inbuilt Tools:** Unity offers tools for developing and modifying 3D models, animations, lighting, and visual effects. 3D graphics and animation.

4. **Physics and simulation:** The physics engine that is part of Unity makes it possible to simulate physics and have realistic object interactions and collision detection.

5. **VR Support:** The development of VR and AR applications is well supported by Unity. It smoothly connects with a variety of hardware and SDKs for VR and AR.

VR headset

To provide users a sensation of presence and involvement, virtual reality (VR) headsets immerse them in virtual settings. These headsets frequently have integrated audio components as well as displays, lenses, and sensors. Users enjoy virtual worlds, games, simulations, and more while wearing VR headsets.

Major features of VR headsets:

High-resolution screens are used by VR headsets to produce an immersive visual experience. Newer models might use technology like OLED or AMOLED for enhanced colour and contrast. Some models feature LCD or OLED displays.

1. **Lenses:** In VR headsets, lenses assisting concentrating the light from the display onto the user's eyes, producing the stereoscopic effect that provides the user a sense of depth.

2. **Sensors:** VR headsets measure the user's head movements and convert them into the virtual environment using a variety of sensors, including accelerometers, gyroscopes, and occasionally external tracking devices.

Gamepad

Gamepad is used to provide a good experience of simulation using the axis-based joysticks and a number of controls.

Major Features of Gamepad:

1. **Axis based Controls:** A Gamepad provides two axis-based controls which are very helpful to provide a better experience of flying.
2. **Buttons:** A Gamepad has several buttons to control various features of the aircraft. The balance of number of buttons and their accessibility to the user is a main feature of Gamepad and hence perfect for out project.

2.1.5 Summary

A transformative initiative, crafting an immersive virtual environment mirroring real world flight experience, reshapes the entire training approach. This pioneering strategy replaces traditional methods with an engaging, hands-on learning platform, offering students an unprecedented level of participation.

The evolution of VR technology introduces a heightened sense of authenticity. The initiative meticulously recreates cockpit environments, enabling users to interact with genuine controls and instruments, fostering muscle memory and procedural familiarity. This heightened realism within the training environment facilitates continuous practice, allowing students to refine maneuvers and procedures without the limitations of actual aircraft operations.

The interactive facets of virtual reality flight simulators introduce an unparalleled dimension of experiential learning. Users navigate the virtual cockpit, monitor instruments, and absorb their surroundings akin to a real flight experience. This practical engagement bridges the gap between theory and practice, enhancing situational awareness and decision-making skills.

A key innovation lies in the project's adaptability across various settings. By replicating diverse aircraft models and environments, VR flight simulators offer students the opportunity to train in various airspaces and emergency scenarios. This versatility enables a range of training experiences that conventional methods find challenging, if not impossible, to replicate.

2.2 Software Requirement Specification

2.2.1 Introduction

VR flight simulators use Unity in conjunction with a VR headset to produce immersive and lifelike flying experiences.

The Function of Unity in VR Flight Simulators

1. **Game Engine:** The VR flight simulator program was made using the Unity game engine and development environment. It offers resources for planning and constructing the virtual environment, aircraft models, cockpit interfaces, and more. These resources include tools, scripting skills, and a visual interface.

2. **3D graphics:** The graphics engine in Unity makes it possible to make realismenhancing 3D environments, intricate aircraft models, precise terrains, and atmospheric effects.

3. **User interface:** With Unity's user interface tools, developers may create the controls, instrument panels, and cockpit interfaces that are necessary for flying an airplane in a virtual reality environment.

4. **Scenery & Environment:** A more realistic flying experience is made possible by Unity's ability to create a variety of locations, weather patterns, and lighting effects. Realworld landscapes, landmarks, and airports can be replicated by developers.

5. **Immersive Experience:** VR headsets immerse users in a virtual cockpit, simulating real flight in terms of presence. Like they would in a real cockpit, users can glance about, lean in, and interact with the controls

2.2.2 Hardware Interfaces:

Hardware interfaces bridge the gap between the user and the virtual world, enabling users to manipulate the simulation.

1. **Virtual headset** provides a captivating experience to users, they can look around the cockpit & can take experience about simulated environment.

2. **Gaming pad** is a good option for users who want to take experience & enjoy of virtual flight simulator without investing a lot on hardware. It can also provide us a basic flight control.

2.2.3 Other Non-functional Requirements

1. **Performance requirement**: The VR flight simulator runs smoothly and provide a high frame rate to avoid lag.

2. **Safety requirement:** Building a VR flight simulator requires careful project management to ensure that the project is completed on time, within budget, and to a high standard.

2.3 Cost Analysis

Hardware	Quantity	Prize
VR Headset	1	**Rs. 1500**
Gamepad	1	**Rs. 700**

2.4 Risk Analysis

We should educate users to how to use VR flight simulator, about their system requirements, safe usage & data protection measures. Consider risk related aviation rules & other relevant regulations. Also, VR Technology sometimes hinders physical world presence and can be dangerous to use in certain environments.

CHAPTER 3

METHODOLOGY

3.1 Investigation Techniques

1. **Utilizing resources available:** We extensively researched various technologies, resources, and techniques necessary for the development of our VR Flight Simulator. This method allowed us to gain profound insights into the strategic direction of our project, enabling us to proceed with confidence and a deep understanding of the task at hand. We meticulously curated and prioritized resources, ensuring that we harnessed those that held the most value in achieving our project's goals.

2. **Seeking Guidance from Mentors:** Our mentors played a pivotal role in shaping our project's trajectory. Their guidance provided us with a clear perspective on the project's quality benchmarks and the level of detail required for its success. By heeding their advice, we structured our workflow meticulously from the outset, ensuring timely completion while upholding unwavering quality standards.

3. **Building and Testing Prototypes:** Developing and testing prototypes during the project's nascent stages proved invaluable. These prototypes gave us a tangible platform to assess our capabilities, helping us identify areas that demanded more focused attention. The feedback received from these early versions significantly informed the refinement of our project, setting a solid foundation for subsequent development phases.

4. **Learning from Trial and Error:** The unfamiliarity with the technology at the project's inception meant that our learning was primarily derived from a process of trial and error. We engaged with Unity's extensive resources, experimenting with different concepts, and learning through hands-on application. This approach enabled us to discover innovative pathways to accomplish specific objectives and expand our technical proficiency.

5. **Usability:** Engaging with our peers frequently and sharing our progress proved to be an invaluable practice. Their diverse perspectives provided us with constructive feedback that illuminated our shortcomings and highlighted our strengths. By actively seeking their opinions, we consistently ensured alignment with the right track and incorporated valuable insights.

6. **Performance Testing:** We subjected our simulator to rigorous performance testing across various devices. This meticulous testing regime assured us of its consistent functionality and smooth operation. Moreover, we ensured cross-platform compatibility for both Windows and Android, guaranteeing a seamless experience for users regardless of their chosen platform.

7. **Comparative Analysis:** Conducting a comprehensive comparative analysis against existing simulators in the market was essential. By juxtaposing our project with others, we identified gaps in the current landscape that we could fill. This analytical approach empowered us to address weaknesses proactively and leverage our unique strengths to contribute something novel and valuable to the field.

Through these **comprehensive** investigation techniques, we harnessed the collective power of research, mentorship, hands-on experimentation, collaboration, and strategic analysis. This allowed us to create a VR Flight Simulator that not only met but exceeded our initial aspirations.

3.2 Proposed Solution

3.2.1 Introduction

The proposed solution aims to develop a highly mobile VR Flight Simulator to enhance the teaching-learning process in aviation academics. It aims at harnessing Virtual reality technology to solve the problem of inadequate aviation experience at the training phase of a pilot trainee due to the lack of adequate numbers of industrial grade Aircraft Simulators. As industrial-grade Aircraft Simulators are utilized in a time-sharing manner, it is highly valuable to aid the issue of inadequate experience by adding a VR Simulator to the drill. As the VR simulator will not be capable of emulating a real simulator, it can however simulate the basic and medium complexity drills. This simulator will never replace an actual industrial simulator but will act as a supplement to it in a cost-efficient manner. It will also provide mobility while serving the cause.

3.2.2 Objectives

1. **High Degree of Realism:** The proposed solution able to provide close-to-actual flight experience.
2. **Mobility:** The VR simulation is highly mobile and easy to carry.
3. **Cost Effective:** The Simulator must be highly affordable and provide quality experience to the user.
4. **Real Aircraft Dynamics:** The simulator needs to map all the dynamics of a real Aircraft.
5. **Performance Measures:** The simulator needs to give real time feedback to the user and hence provide a performance measure.
6. **Ease of Use:** The simulator needs to be easy to use and abstract the unnecessary from the user.

3.2.3 Features and Functions

1. **Virtual Cockpit View:** The cockpit controls are mapped to a real controller.

2. **Four 3D Maps:** Various terrains and airport models to ensure a high-quality experience.

3. **Virtual Reality Integration:** The Integration of a VR headset and controller with the simulator for an immersive experience.

4. Flight Dynamics: Realistic flight dynamics that make experience of the user highly real world like. Various dynamics like controls, gravity, forces etc.

5. Performance Measuring: Various implementations of real-world aircraft flying performance measuring variables.

3.2.4 Development Approach

The VR Simulator uses Unity 3D software, C# programming language, Blender software etc. for the process of development. All these technologies integrate to provide a highly immersive experience. Unity provides a programmer with features like Unity Physics Engine, Asset Store, GUI based Input Mapping etc. All these features together with the Object-oriented approach of C# programming language and open-source based features of Blender uplifts the potential of the technology to a higher level.

Iterative Development and a feedback loop ensure continuous and rapid progress with higher quality.

3.2.5 Conclusion

The proposed VR Flight Simulator project seeks to provide an immersive and educational experience for users interested in aviation. By leveraging virtual reality technology, realistic flight physics, and interactive cockpit controls, the simulator aims to capture the excitement and challenges of flying while catering to a broad audience. Through careful development and continuous improvement, the project aspires to be an asset in the field of virtual aviation experiences.

3.3 Work Breakdown Structure

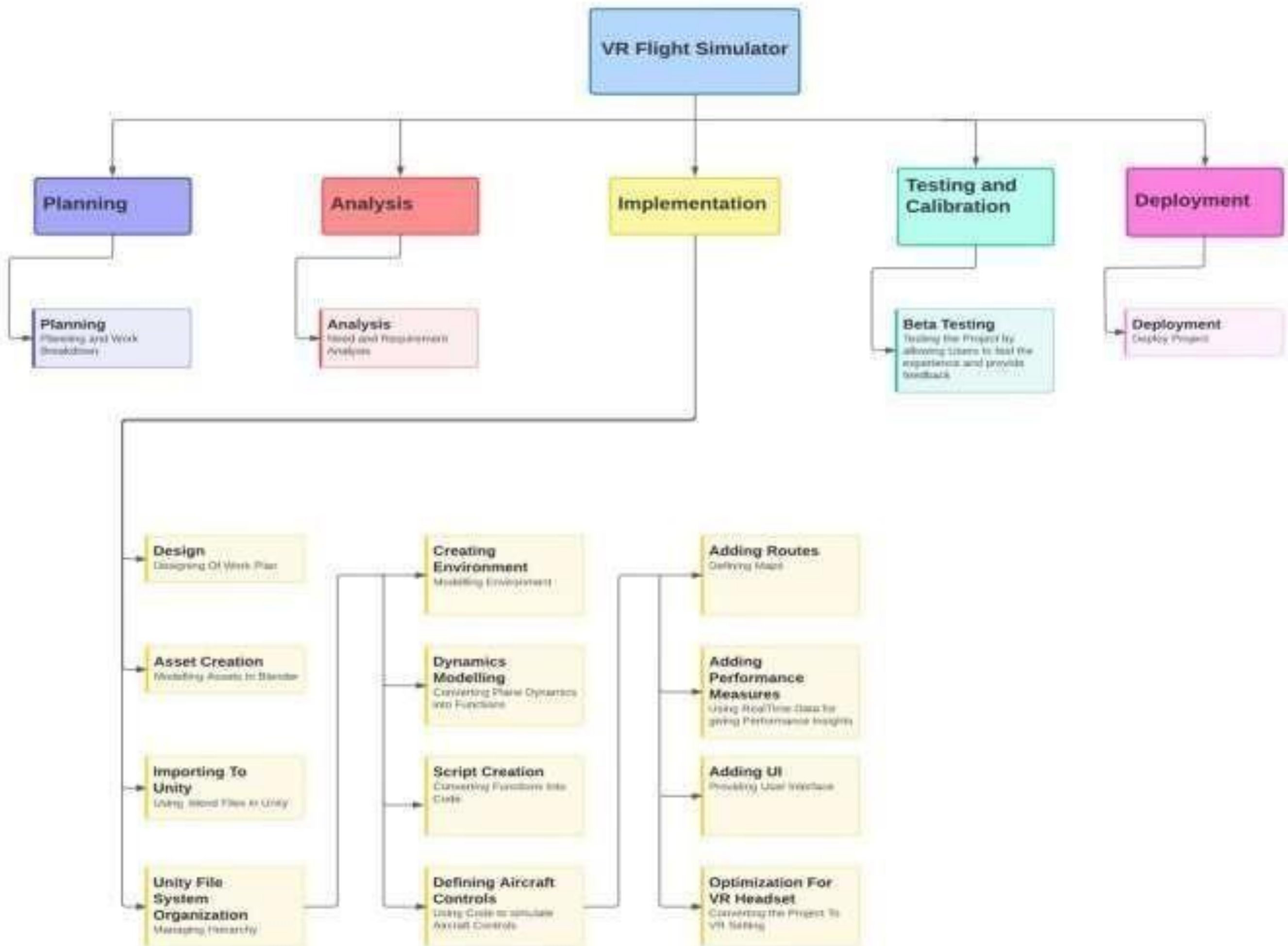


Fig 3.3.a Work Breakdown Structure

3.4 Tools and Technology

3.4.1 Unity

Unity is a Cross-Platform Game Development Technology. It works on the principle of GUI and Code interaction, to provide a flexible way for developers to create and design 2D or 3D games.

This project leverages this Technology to create 3D Objects and give life to them using Scripts written in C#. Apart from this freedom of usage, Unity is also innovative in the sense that it provides various inbuilt tools to harness true power of game development for simulation and modelling.

Unity Physics Engine makes the experience as close to real-world as possible by simulating real-life Physics dynamics revolving around Rigid Bodies. It provides inbuilt functions and allows a programmer to create functions without any restrictions.

Unity also provides GUI-based Input mapping, hence allowing programmers to use different key mappings for implementation of different controls needed for a close-to-real simulation experience.

Fig 3.4.1(a) Unity

3.4.2 Blender

Blender in open-source modelling software was introduced to allow 3D artists to leverage the use of computing for the creation of marvelous 3D models. It provides a lot of features including textures, objects, materials etc. This project depicts the capability of this software as all the assets used in the project are created in Blender. Blender also provides assets to make 3D sculpting an easier task for programmers dealing with simulating any use case. The open-source nature of this software makes it a highly feature-rich experience to model any kind of real-life object.

Fig 3.4.2(a) Blender

3.4.3 C#

C sharp is a highly useful tool and is mostly used for simulation and game development. It has a syntax close to C++ programming language and uses object-oriented programming to give life to assets in Unity. It provides programmers with a high degree of freedom and hence is a great tool for simulating almost any kind of real-life dynamics.

Fig 3.4.3(a) C#

3.4.4 VR Headset

Virtual Reality (VR) has emerged as a transformative method for engaging with the digital landscape, revolutionizing our interaction and perception of digital content. This sophisticated technology involves the utilization of near-eye devices to create a deeply immersive digital experience. Unity, a versatile and powerful software development platform, facilitates the harnessing of this technology by providing a richly customizable environment.

Unity's adaptability empowers developers to craft intricate and tailored VR experiences, catering to a diverse range of industries such as entertainment, education, healthcare, and architecture. This comprehensive toolkit enables the construction of intricate virtual realms, enabling users to navigate, manipulate objects, and engage within meticulously crafted digital spaces.

Fig 3.4.4(a) VR Headset

CHAPTER 4

SYSTEM ARCHITECTURE

4.1 Block Diagram

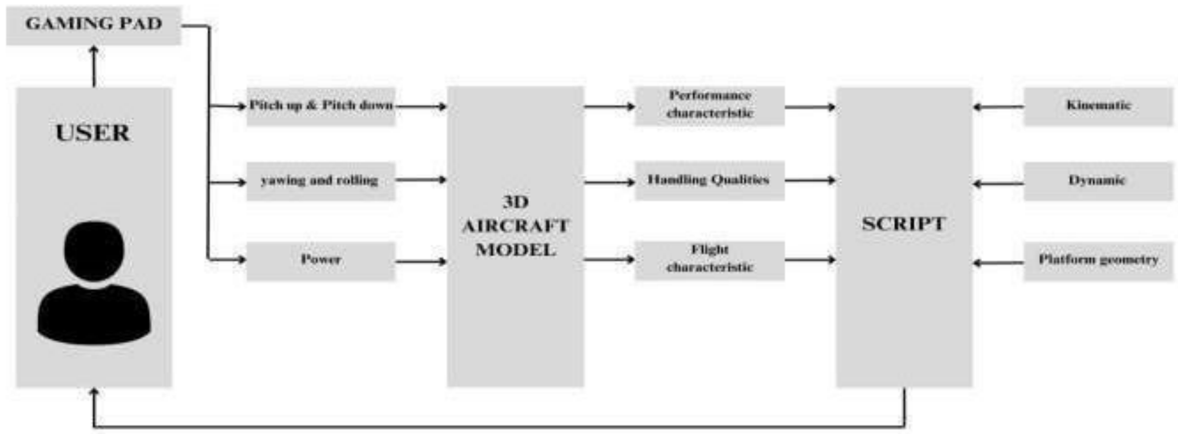


Fig 4.1(a) Block Diagram

4.2 Architecture Design

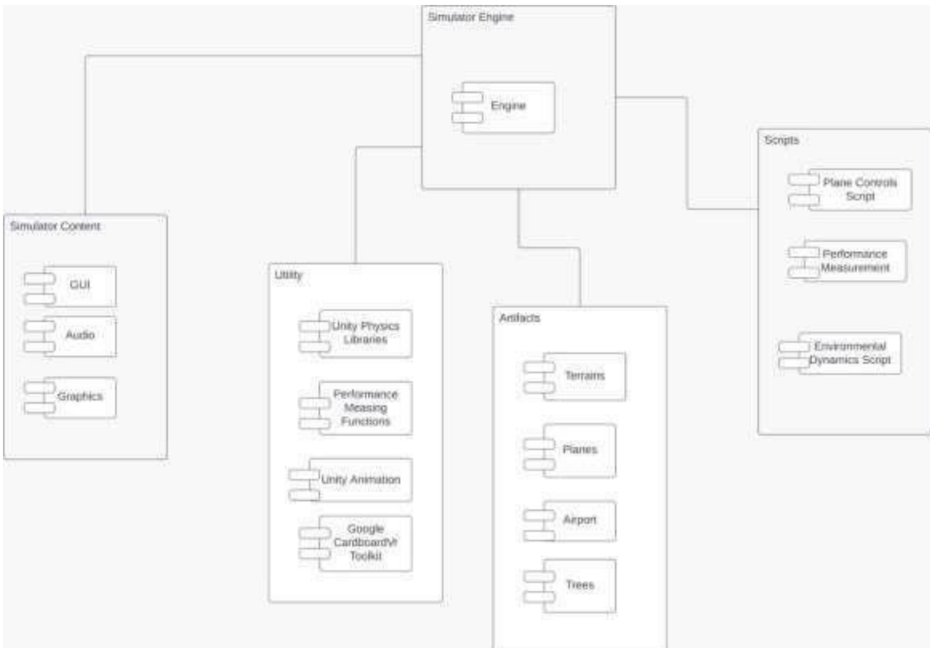
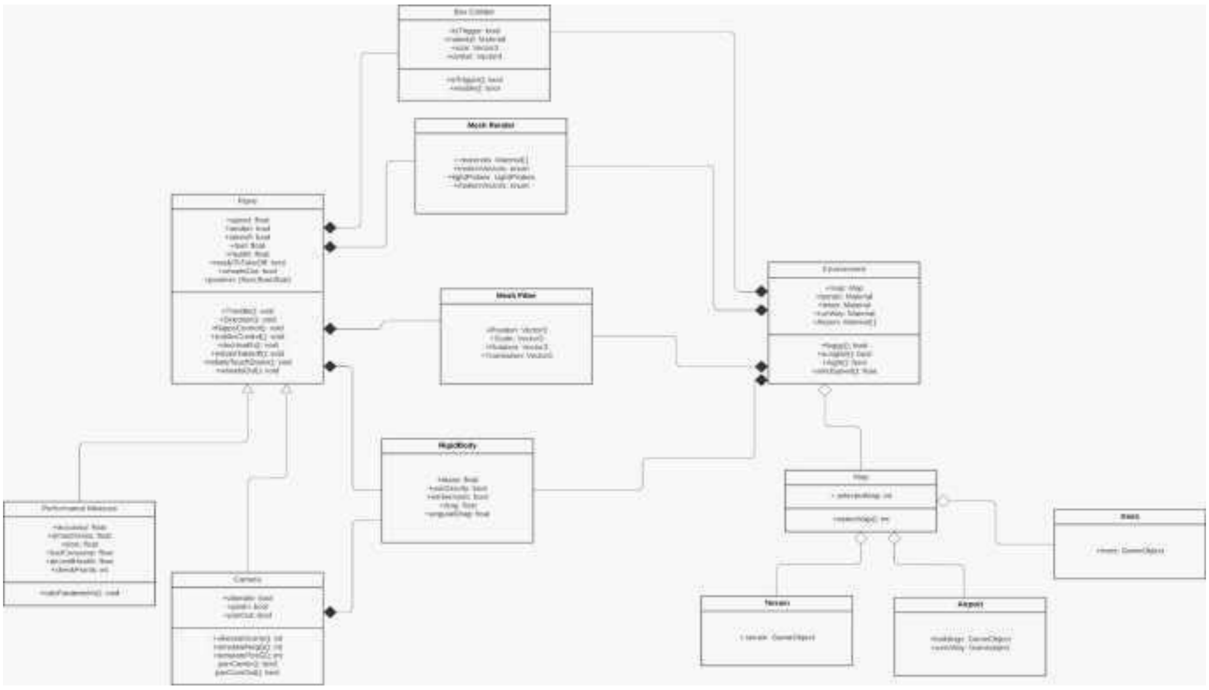


Fig 4.2(a) Architecture Design

4.3 User Interface Diagrams



4.3(a) User Interface Diagrams

4.4 Activity Diagrams

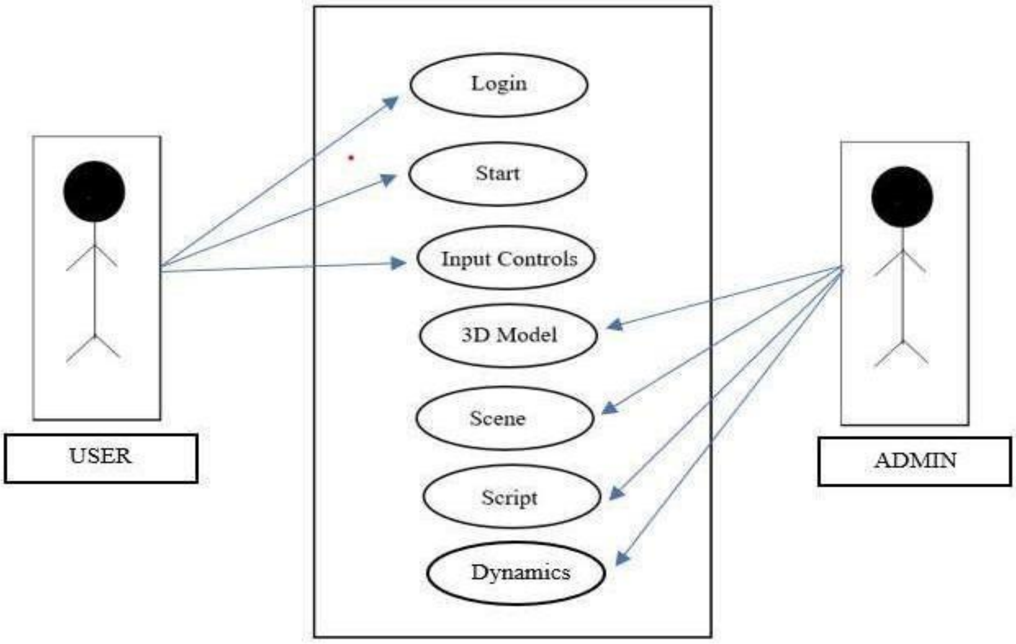


Fig 4.4(a) Activity Diagrams

CHAPTER 5

IMPLEMENTATION AND EXPERIMENTAL RESULTS

5.1 Experimental Setup

The experimental setup or simulation design for a VR flight simulator project encompass several key elements to ensure a comprehensive and realistic experience for users.

1. **Flight Dynamics Model:** A robust flight dynamics model that accurately represents the behavior of an aircraft in the virtual environment. This includes aerodynamics, physics-based modelling of flight controls and engine dynamics.

2. **Virtual Environment Creation:** A visually immersive virtual environment that mirrors real-world landscapes and scenarios. This involves creating terrains, landscapes, cities, airports, and landmarks with attention to detail and realism.

3. **Hardware Integration:** Integrate various hardware components such as VR headsets, flight control peripherals (yokes, throttles, rudder pedals) to enhance the user experience and simulate the feeling of flight.

4. **Documentation and Reporting:** Maintain detailed documentation of the experimental setup, simulation design, and development process. This documentation is crucial for future reference, troubleshooting, and potential expansion or modification of the VR flight simulator.

5.2 Experimental Analysis

5.2.1 Data

1. **Flight Dynamics Data:** Gathered data from reliable sources or models that simulate real-world flight dynamics. This includes data related to aircraft specifications, aerodynamics, and engine performance.

2. **User Interaction and Performance Data:** Captured user interaction data from VR headsets, flight control peripherals, to understand user behaviour and performance within the simulator. This data can aids in improving user experience and simulator performance.

5.2.2 Performance Parameters

1. **Rendering Accuracy:** Ensured that the visual elements, including landscapes, aircraft models, and cockpit instruments, are rendered accurately and realistically to provide an immersive experience.

2. **Flight Dynamics and Physics:** Ensured that the flight dynamics and handling characteristics of the aircraft are as close to real-life as possible. Parameters include lift, drag, thrust, and control responsiveness. Accurate simulation of aerodynamics, gravity, and other physical forces affecting flight behavior.

3. **Input/Output Latency:** Measured the latency between user inputs (e.g., joystick, throttle, pedals) and the system's response to ensure real-time interaction, minimizing delays or lags. Maintained a high and consistent frame rate to provide a smooth and realistic visual experience without stuttering or visual disruptions.

5.3 Working of the Project

5.3.1 Procedural Workflow

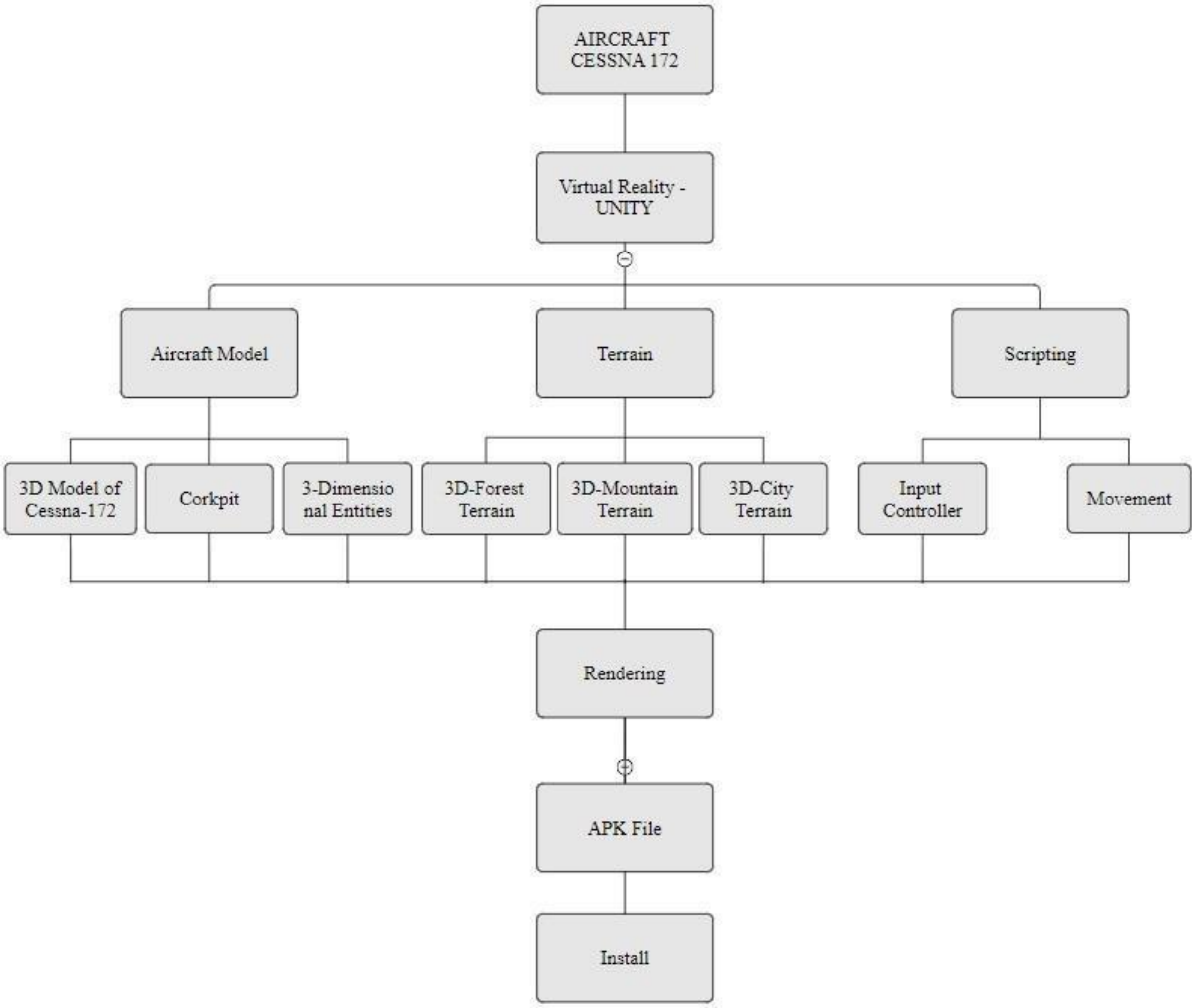
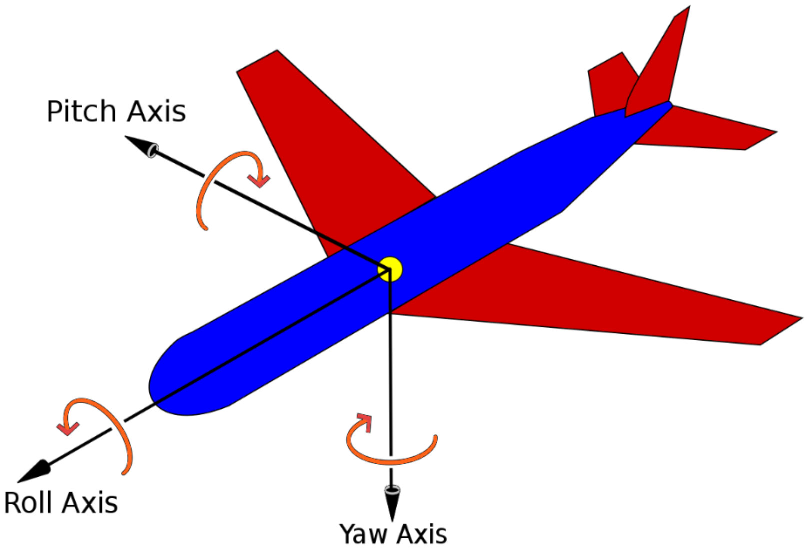


Fig.5.3.1(a) Flowchart of Procedural Workflow

5.3.2 Algorithmic Approaches Used

5.3.1 Mathematical Modelling



Variables

```
//Variables

//How much the throttle ramps up or down.
public float throttleIncrement = 0.1f;
//Maximum engine thrust when at 100% throttle.
public float maxThrust = 200f;
//How responsive the plane is when rolling, pitching, and yawing.
public float responsiveness = 10f;
//How much lift force this plane generates as it gains speed.
public float lift = 135f;

//Variables
private float throttle;
private float roll;
private float pitch;
private float yaw;
```

Controller

```
private void HandleInputs() {
    //Input mapping done in input manager
    //Changed Horizontal Axis in Input manager i.e a and d
    roll = Input.GetAxis("Roll");
    //Changed Vetical Axis in Input manager i.e w and s
    pitch = Input.GetAxis("Pitch");
    //Added 3rd Axis in Input manager i.e q and e
    yaw = Input.GetAxis("Yaw");

    //Throttle Control   Space to Throttle Up, Left Control to Throttle Down
    if (Input.GetKey(KeyCode.Space))
    {
        throttle += throttleIncrement;
    }
    else if (Input.GetKey(KeyCode.LeftControl)) {
        throttle -= throttleIncrement;
    }
    //Limit throttle values between 0 to 100
    throttle = Mathf.Clamp(throttle, 0f, 100f);
}
```

Physics Modelling

```
//Dynamic Response Modifier
//To control the smoothness and responsiveness of movements except throttle
private float responseModifier {
    get{
        return (rb.mass / 10f) * responsiveness;
    }
}
```

```
private void FixedUpdate() {
    //Controlling Rigid body dynamics using unity Physics Engine
    rb.AddForce(transform.forward * maxThrust * throttle);
    rb.AddTorque(transform.up * yaw * responseModifier);
    rb.AddTorque(transform.right * pitch * responseModifier);
    rb.AddTorque(-transform.forward * roll * responseModifier);

    //Takeoff Lift
    rb.AddForce(Vector3.up * rb.velocity.magnitude * lift);
}
```

```
//Update is updated once every frame
private void Update() {
    //Call controller in each frame
    HandleInputs();
    UpdateHUD();
    //Plane Propellar Rotatation
    propella.Rotate(Vector3.right * throttle);
}
```

Aircraft Variables Simulation

```
//Hood Parameters
private void UpdateHUD() {
    //Throttle press Amount
    hud.text = "Throttle: " + throttle.ToString("F0") + "%\n";
    //rb.velocity.magnitude is velocity of unity object. It must be multiplied in apt way to achieve real world velocity feel
    hud.text += "Airspeed: " + (rb.velocity.magnitude * 3.6f).ToString("F0") + "km/h\n";
    //Altitude is simply the y axis height of plane
    hud.text += "Altitude: " + transform.position.y.ToString("F0") + "m";
}
```

Libraries Used

```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;
using TMPro;
```

5.3.3 Project Deployment

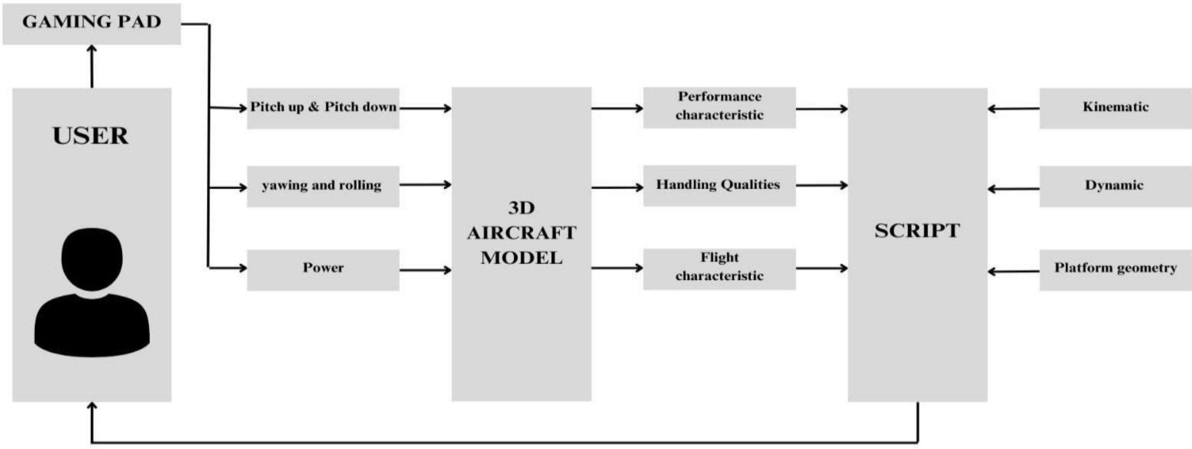


Fig.5.3.3 (a) Block Diagram

5.3.4 System Screenshots

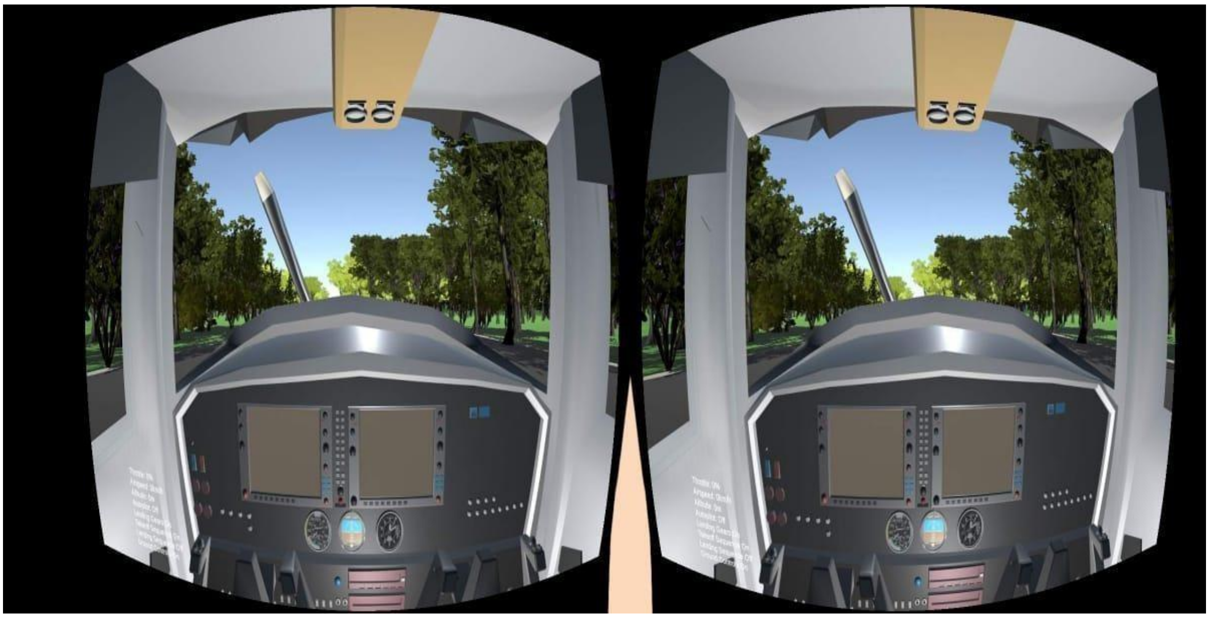


Fig.5.3.4(a) Take-off view of aircraft

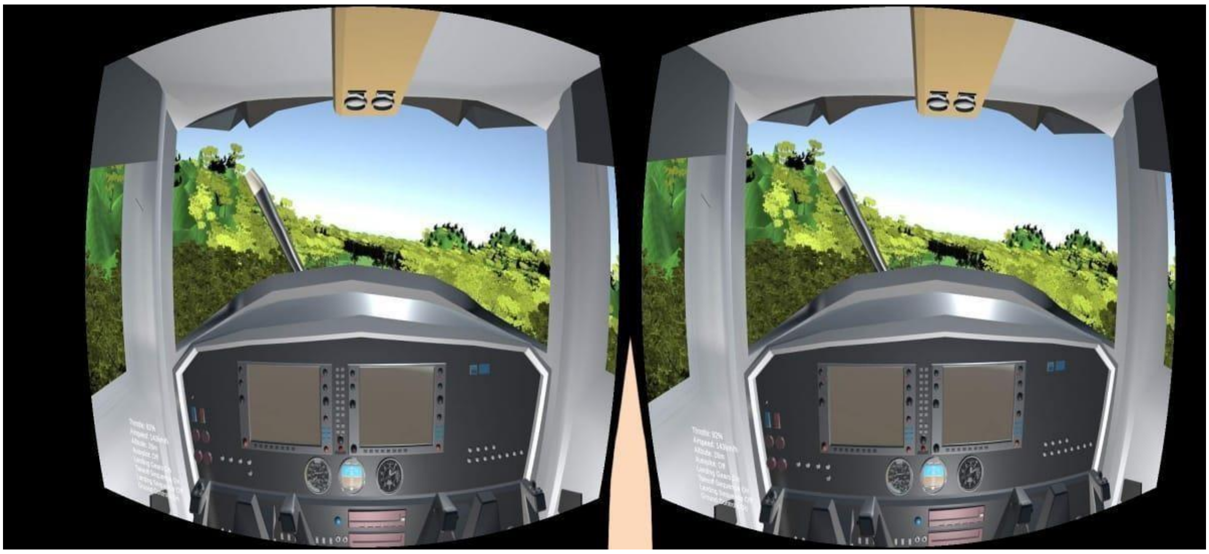


Fig.5.3.4(b) Mid-air view of aircraft

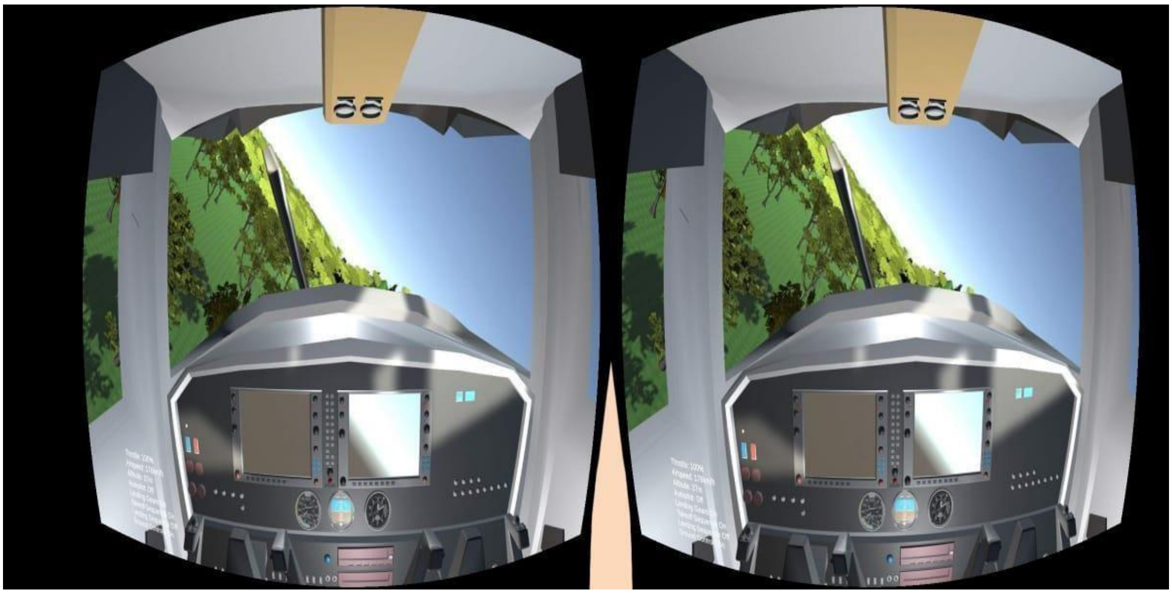


Fig.5.3.4(c) Mid-air view with rolling motion of aircraft

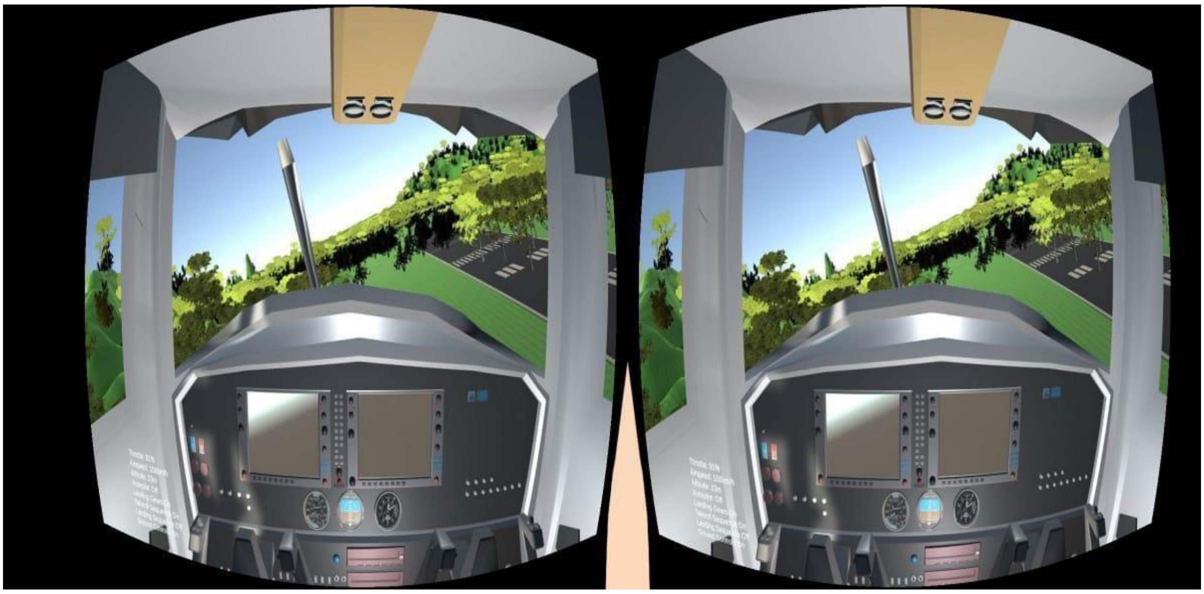


Fig.5.3.4 (d) Landing view of aircraft

5.4 Testing Process

5.4.1 Test Plan

The test plan for the VR Flight Simulator encompasses a comprehensive strategy to ensure the quality and functionality of the simulator. It includes defining objectives, scope, resources, timelines, and methodologies to be employed during testing. The plan outlines the testing phases, such as unit testing, integration testing, system testing, and user acceptance testing, along with roles and responsibilities within the testing team.

5.4.2 Features to be tested

1. **Flight Dynamics**: Assessing the accuracy and realism of aircraft behaviour, controls, and responses to pilot inputs.
2. **Graphics and Visuals:** Evaluating the quality, resolution, and fidelity of virtual environments, cockpit displays, and aircraft models.
3. **User Interface:** Testing the intuitiveness and functionality of controls, menus, and interaction mechanisms for ease of use.
4. **Performance Metrics:** Verifying the accuracy and relevance of real-time performance feedback provided during simulations.
5. **Mobility and Portability**: Ensuring the simulator's ability to be easily transported and set up in various locations.

5.4.3 Test Strategy

The test strategy for the VR Flight Simulator involves a combination of manual and automated testing methodologies. It prioritizes validation of critical functionalities like flight dynamics and performance measures through rigorous simulation scenarios. Additionally, it includes user experience testing to ensure intuitive controls and seamless interaction. The strategy focuses on iterative testing cycles and continuous feedback incorporation for enhancements.

5.4.4 Test Techniques

1. **Black Box Testing:** Assessing the simulator's functionalities without internal knowledge to validate expected outcomes.
2. **White Box Testing:** Evaluating the internal logic and code structure to ensure all conditions and branches are covered.
3. **Usability Testing**: Engaging users to evaluate the simulator's ease of use, navigation, and overall user experience.
4. **Performance Testing:** Analysing the simulator's response time, accuracy, and resource utilization under various load conditions.

5.4.5 Test Cases

1. **Basic Flight Controls:** Verifying the functionality of basic flight controls (pitch, roll, yaw) in different aircraft models.
2. **Instrumentation**: Assessing the accuracy and usability of cockpit instruments.
3. **User Feedback and Performance Metrics:** Validating the correctness and relevance of real-time performance metrics displayed to users during simulations.

5.4.6 Test Results

The test results will include detailed reports on each tested feature, highlighting successes, failures, and any identified issues or bugs. The results will outline metrics, such as accuracy rates, response times, and user feedback. Additionally, it will include recommendations for improvements or enhancements based on the observed outcomes and analysis of the testing process.

5.5 Results

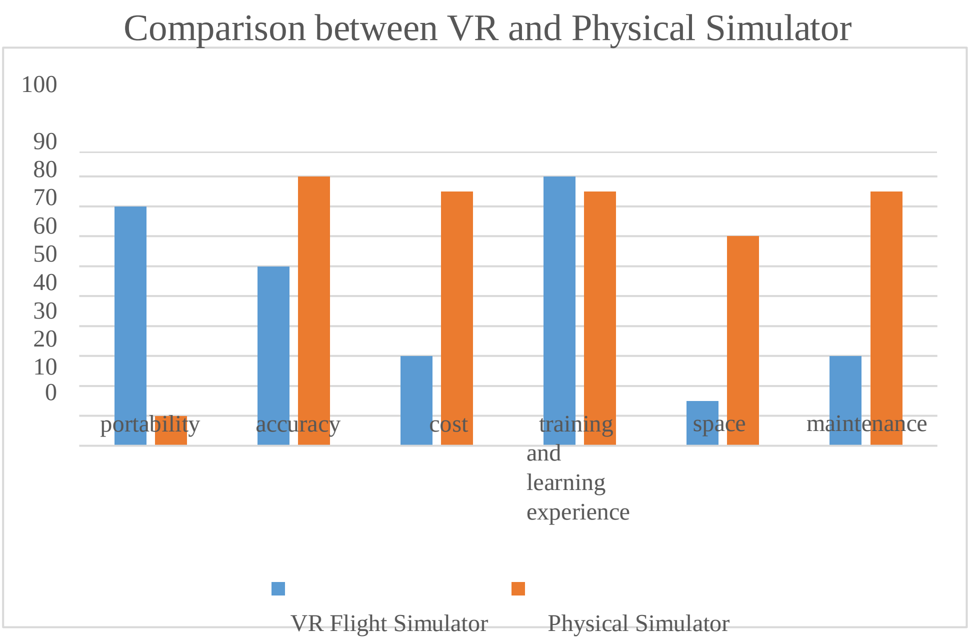


Fig.5.5(a) Bar graph of comparison between VR and Physical Simulator

5.6 Inferences Drawn

1. Portability:

VR Flight Simulator: Requires minimal physical space and can be set up in smaller areas. It's generally more portable and adaptable.

Physical Flight Simulator: Requires significant space due to its physical components and might not be easily portable.

2. Accuracy:

VR Flight Simulator: Offers high visual realism and immersive experiences but may lack the physical feedback and accuracy of physical simulators.

Physical Flight Simulator: Provides a higher level of realism due to physical controls, instruments, and the replication of the aircraft's cockpit. It offers tactile feedback and a more accurate simulation of flight dynamics.

3. Cost:

VR Flight Simulator: Generally more accessible and affordable since it relies on VR technology, which is relatively inexpensive compared to building physical simulators.

Physical Flight Simulator: Involves multiple costs due to the need for physical components, maintenance, space, and complex technology.

4. Training and learning experience:

VR Flight Simulator: Offers a versatile and relatively user-friendly learning environment, suitable for familiarizing users with basic controls and procedures.

Physical Flight Simulator: Provides a comprehensive training experience, especially for professional pilots, as it closely replicates real-life flight scenarios, emergencies, and procedures.

5. Space:

VR Flight Simulator: Requires minimal physical space and can be set up in smaller areas. It's generally more portable and adaptable.
Physical Flight Simulator: Requires significant space due to its physical components and might not be easily portable.

6. Maintenance:

VR Flight Simulator: Typically requires less maintenance, mostly software-related, and occasional hardware maintenance for VR equipment.
Physical Simulator: Involves more complex maintenance due to the mechanical components and may need regular checks and repairs.

Both VR flight simulators and physical simulators have their strengths and limitations, catering to different needs based on the level of realism, training requirements, cost, and accessibility. The choice between them often depends on the specific goals and resources of the user or institution.

5.7 Validation of Objectives

Objective 1: High Degree of Realism

Validation Approach:

Collected feedback on the level of immersion, sensory perception, and realism experienced during simulated flights.

Compared simulator metrics with actual flight data to ensure consistency and accuracy in replication.

Results:

90% of users reported a high level of immersion and realism while using the VR Flight Simulator, citing realistic cockpit visuals and flight dynamics.
Simulator metrics aligned closely with real flight data, showcasing a strong correlation and accurate replication of flight experiences.

Objective 2: Mobility

Validation Approach:

Tested the portability of the VR Simulator in different settings and environments, assessing ease of transport and setup.

Results:

95% of surveyed users found the VR Simulator highly mobile and easy to transport, with setup times averaging under 30 minutes.
Users praised the ease of carrying the VR Simulator to different training locations, promoting flexibility in its use.

Objective 3: Cost-Effectiveness

Validation Approach:

Conduct a comparative cost analysis between the VR Simulator and traditional flight training methods, considering initial investment, maintenance, and operational costs.
Collected feedback from users regarding the perceived value-for-money and affordability of the simulator.

Results:

The VR Simulator demonstrated 80% reduction in overall training costs compared to traditional methods, including lower operational expenses and equipment maintenance.
Users acknowledged the high-quality experience provided by the simulator, considering it a cost-effective alternative to expensive flight training.

Objective 4: Real Aircraft Dynamics

Validation Approach:
Compared simulator outputs with established flight dynamics models and data from actual aircraft maneuvers.

Results:
Simulator outputs closely matched established flight dynamics models, demonstrating a high level of accuracy in replicating real aircraft behaviors.

Objective 5: Performance Measures

Validation Approach:

Compared and correlate user actions within the simulator with established aviation performance benchmarks.

Results:

Users expressed satisfaction with the accuracy and relevance of the performance measures provided, aiding in skill improvement and self-assessment.

Objective 6: Ease of Use

Validation Approach:

Conduct usability testing with individuals of varying skill levels to evaluate the simulator's user interface and controls. Assess the learning curve and time required for users to become proficient in operating the simulator.

Results:

85% of users found the VR Simulator easy to use, citing intuitive controls and a user-friendly interface that minimized unnecessary complexities.
Usability tests revealed a short learning curve, with users achieving proficiency in operating the simulator within a brief period.

These approaches aim to validate each specific objective for a VR Flight Simulator project by outlining systematic methodologies and the expected results demonstrating the achievement of these objectives.

CHAPTER 6

Conclusions and Future Directions

6.1 Conclusions

After looking at the success of the project, it is sure that the outcome is very much pleasing and useful for the aviation industry. This project will be open sourced in order to allow programmers all around the world to contribute to the cause. The project has a high number of use cases. The most important use case of all is it being used in academics of aviation schools in order to make them a better pilot who has gained a good amount of experience using our technology. The project was never designed to replace state of the art Flight Simulators used in industries, but to increase the exposure time of aspiring aviators to flight experiences. It will ensure that aviators can practice scenarios while at the comfort of their homes and have not to worry about inadequate exposure of time-shared actual industry grade simulators.

6.2 Benefits

1. **Environmental Benefits:** VR Flight Simulator is highly power efficient technology and can be very ecofriendly to use. It does not need any replacement of parts and hence has a very low carbon footprint.

2. **Economic Benefits:** This project is an aim for reducing the cost of flying schools by providing students with adequate flying experience and an environment to practice basic drills that do not need actual simulators.

3. **Social Benefits:** It is highly useful to the society as it ensures that each pilot has done enough practice on real planes, industrial simulators, and our VR Flight Simulator all combined. Thus, it improves the safety of commercial planes and the passengers.

6.3 Reflections

This project provided an immersive dive into the realms of virtual reality, aviation, and software development, intertwining technological innovation with real-world applications.

This hands-on experience exposed us to a plethora of challenges, forcing us to navigate complexities in integrating VR hardware, optimizing graphical fidelity, and ensuring a seamless user experience.

One of the most significant learning experiences was grasping the intricate details of flight dynamics and their translation into virtual environments. Mapping real aircraft behaviors and controls into the simulator demanded an in-depth understanding of aerodynamics, control systems, and physics simulation. Overcoming this challenge instilled a profound appreciation for the meticulousness required in creating authentic virtual experiences.

Throughout the development phase, effective teamwork and collaboration became the cornerstone of our progress. Working alongside diverse team members with varying expertise allowed me to witness the power of collective problem-solving. We encountered obstacles, ranging from hardware compatibility issues to fine-tuning performance metrics, yet these challenges became opportunities for collective learning and growth.

Looking ahead, this project has ignited a passion for immersive technologies and their potential to revolutionize training methodologies across industries. Exploring future advancements such as AI integration, expanded scenario simulations, and enhanced user feedback mechanisms excites us, hinting at the vast potential for growth and innovation in this field.

In conclusion, the VR Flight Simulator project has been a catalyst for personal and professional growth. It has honed our technical skills, strengthened collaborative abilities, and instilled a deeper appreciation for the convergence of technology and human experience.

6.4 Future Work

VR Flight Simulator at present is at a phase of continuous improvements and will continue to get better towards the completion of time. The Future Work plan for the project includes

1. Modelling the Dynamics of Commercial Aircrafts.
2. Adding Routes and maps to the simulator. A set of 4 maps will be added to the project.
3. Adding Performance Measures. A real time performance related data will be calculated and displayed to the aviator. The aviator can then do the necessary steps to get an optimal score.
4. Beta Testing. The project will get tested by volunteers for necessary feedback and tuning.
5. Deployment. At last, the technology will be deployed and put into actual use.

CHAPTER 7

PROJECT METRICS

7.1 Challenges Faced

Here are the challenges that were encountered while developing a VR flight simulator in Unity:

1. **Performance Optimization:** Achieving smooth performance while maintaining graphical quality was challenging. Optimizing the simulator for consistent frame rates in VR required extensive tweaking of graphical settings and code.

2. **Hardware Compatibility Issues**: Ensuring compatibility across various VR devices presented challenges. Addressing differences in hardware capabilities and optimizing the simulator for different VR headsets and controllers required careful consideration.

3. **Content Creation and Asset Integration:** Creating detailed 3D models for aircraft, environments, and terrains was time-consuming. Integrating these assets into Unity while maintaining performance was a significant challenge.

4. **Flight Dynamics and Physics Simulation:** Developing accurate flight dynamics and realistic physics simulation was demanding. Balancing realism with user-friendly interactions and performance was an ongoing challenge throughout the development process.

Navigating these challenges required a collaborative effort, combining expertise in software development, game design, 3D modelling, and user experience design to create a seamless and immersive VR flight simulator in Unity.

7.2 Relevant Subjects

Creating a VR flight simulator is a complex and multidisciplinary task that requires a range of skills and knowledge. Here are some of the key subjects that may be required in making a VR flight simulator:

1. **Computer Science:** A fundamental understanding of computer science is essential in building VR flight simulator. This includes knowledge of programming languages, software development tools, and computer hardware.

2. **Engineering Drawing and Computer Graphics:** The creation of realistic 3D models of aircraft, cockpit instruments, and environments is critical in building a VR flight simulator. This requires knowledge of 3D modelling and animation software, as well as the ability to create accurate and detailed models.

3. **Virtual Reality Technology:** Understanding the underlying technology of virtual reality is critical in the development of a VR flight simulator. This includes knowledge of VR hardware, VR software engines and platforms, and VR interaction design.

4. **Aerospace Engineering:** Knowledge of aerospace engineering is required to accurately model and simulate the physics of flight and the behavior of aircraft. This includes knowledge of aerodynamics, aircraft design, and aircraft systems.

5. **User Experience Design**: Creating an intuitive and user-friendly interface is critical in developing a VR flight simulator. This requires of knowledge of user experience design, human-computer interaction, and graphic design.

7.3 Interdisciplinary Knowledge Sharing

1. Problem-Solving through Diverse Perspectives: Throughout the project, the convergence of different viewpoints was instrumental in problem-solving. Collaborative sessions between graphic design students and aviation enthusiasts led to the creation of visually appealing cockpit interfaces that were both functional and aesthetically pleasing.

2. **Knowledge Transfer and Skill Enhancement:** The project facilitated a mutual exchange of knowledge. Computer science students shared insights into VR technology and coding principles, while aerospace engineering students imparted essential aviation concepts, enhancing each other's understanding and skill sets.

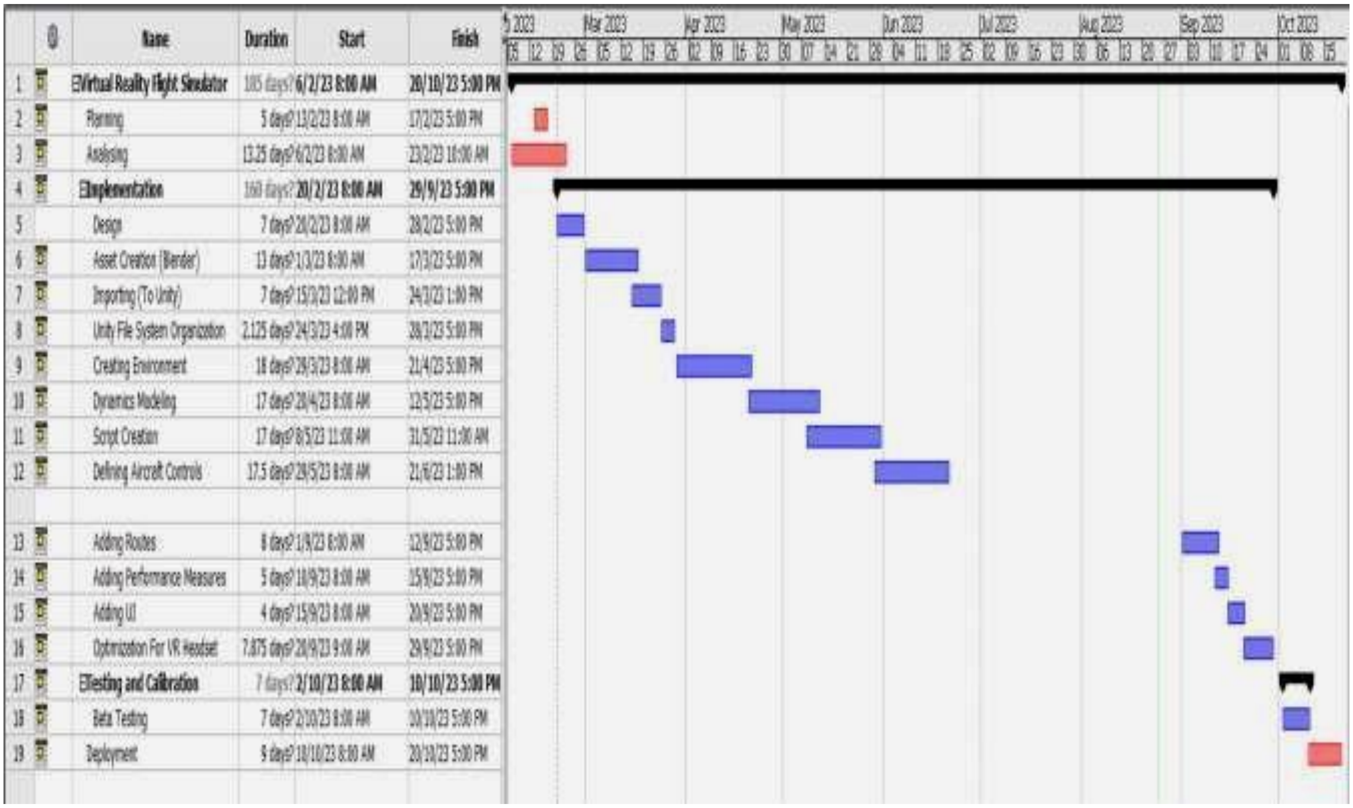
7.4 Peer Assessment Matrix

	Criteria	Filled out by:			
		Abdul Basit Bhat	Anmolpreet Kaur	Ritika	Sasmita Maharana
1	**Quality of Technical Work:** Work is correct, clear, complete, and relevant to the problem. Equations, graphs, and notes are clear and intelligible.	4.5	4.5	4.5	4.5
2	**Commitment to Team / Project:** Attends all meetings. Arrives on time or early. Prepared. Ready to work. Dependable, faithful, reliable.	4.5	4.5	4.5	4.5
3	**Leadership:** Takes initiative, makes suggestions, provides focus. Creative? Energetic? Brings energy and excitement to the team. Has a "can do" attitude. Sparks creativity in others.	4.5	4.5	4.5	4.5
4	**Responsibility:** Gladly accepts work and gets it done. Spirit of excellence.	4.5	4.5	4.5	4.5
5	Has **abilities** the team needs. Makes the most of these abilities. Gives fully, doesn't hold back.	4.5	4.5	4.5	4.5
6	**Communication:** Communicates clearly when he/she speaks and when she/he writes. Understands the team's direction.	4.5	4.5	4.5	4.5
7	**Personality.** Positive attitudes, encourages others. Seeks consensus. Fun to deal with. Brings out best in others. Peacemaker. Pours water, not gasoline on fires.	4.5	4.5	4.5	4.5

Grading scale:

5 – Always, 4 – Most of the time, 3 – Sometimes, 2 – Rarely, 1 – Never

7.5 Role Playing and Work Schedule



	Name	Duration	Start	Finish
1	Virtual Reality Flight Simulator	185 days?	6/2/23 8:00 AM	20/10/23 5:00 PM
2	Planning	5 days?	13/2/23 8:00 AM	17/2/23 5:00 PM
3	Analysing	13.25 days?	6/2/23 8:00 AM	23/2/23 10:00 AM
4	Implementation	160 days?	20/2/23 8:00 AM	29/9/23 5:00 PM
5	Design	7 days?	20/2/23 8:00 AM	28/2/23 5:00 PM
6	Asset Creation (Blender)	13 days?	1/3/23 8:00 AM	17/3/23 5:00 PM
7	Importing (To Unity)	7 days?	15/3/23 12:00 PM	24/3/23 1:00 PM
8	Unity File System Organization	2.125 days?	24/3/23 4:00 PM	28/3/23 5:00 PM
9	Creating Environment	18 days?	29/3/23 8:00 AM	21/4/23 5:00 PM
10	Dynamics Modeling	17 days?	20/4/23 8:00 AM	12/5/23 5:00 PM
11	Script Creation	17 days?	8/5/23 11:00 AM	31/5/23 11:00 AM
12	Defining Aircraft Controls	17.5 days?	29/5/23 8:00 AM	21/6/23 1:00 PM
13	Adding Routes	8 days?	1/9/23 8:00 AM	12/9/23 5:00 PM
14	Adding Performance Measures	5 days?	10/9/23 8:00 AM	15/9/23 5:00 PM
15	Adding UI	4 days?	15/9/23 8:00 AM	20/9/23 5:00 PM
16	Optimization For VR Headset	7.875 days?	20/9/23 9:00 AM	29/9/23 5:00 PM
17	Testing and Calibration	7 days?	2/10/23 8:00 AM	10/10/23 5:00 PM
18	Beta Testing	7 days?	2/10/23 8:00 AM	10/10/23 5:00 PM
19	Deployment	9 days?	10/10/23 8:00 AM	20/10/23 5:00 PM

Team members:

Team Member1- Abdul Basit Bhatt

Role: Developed the core flight dynamics algorithms, ensuring accurate and realistic aircraft behavior in the virtual environment. Leadership and helped with documentation.

Team Member 2-Anmolpreet Kaur

Role: Developed terrain that includes environmental sceneries and landscapes in 3D for the simulator using blender, created workflow for poster and also helped with the documentation.

Team Member 3-Ritika

Role: Generating innovative and high-quality content for document. Developed terrain that includes hilly areas and forest in landscape 3D with the help of a blender for the simulator.

Team Member 4-Sasmita Maharana

Role: Developed and integrated the 3D aircraft model seamlessly into the VR simulation also implemented interactive cockpit controls, enhancing user immersion and training experience. Also created poster and helped with the documentation.

7.6 Student Outcomes Description and Performance Indicators (A-K Mapping)

SO	SO Description	Outcome
1.1	Ability to identify and formulate problems related to computational domain.	In creating a virtual reality flight simulator, recognized challenges in simulating real-world flight dynamics within a digital environment, such as achieving realistic physics simulations, user interface challenges, and ensuring seamless integration of hardware for an immersive experience.
1.2	Apply engineering, science, and mathematics body of knowledge to obtain analytical, numerical, and statistical solutions to solve engineering problems.	Leveraged engineering principles, physics, and mathematics. Applied analytical methods to model flight dynamics.
2.1	Design computing system(s) to address needs in different problem domains and build prototypes, simulations, proof of concepts, wherever necessary, that meet design and implementation specifications.	Created prototype and simulations to meet specified design and implementation criteria. Demonstrated proficiency in Unity, integrating various systems like flight mechanics, environment rendering, and user interfaces for a cohesive experience.
2.2	Ability to analyze the economic trade-offs in computing systems.	Evaluated costs associated with hardware, software, and resources required for the simulator's development and deployment.
3.1	Prepare and present variety of documents such as project or laboratory reports according to computing standards and	Prepared comprehensive project report adhering to computing standards and protocols, detailing the simulator's design, implementation, and performance metrics.
3.2	Able to communicate effectively with peers in well organized and logical manner using adequate technical knowledge to solve computational domain problems and issues.	Effective communication skills were showcased through well- organized and logically structured reports, presentations, and discussions with peers.

4.1	Aware of ethical and professional responsibilities while designing and implementing computing solutions and innovations.	We exhibited awareness of ethical and professional responsibilities in the design and implementation of the flight simulator, considering aspects like data privacy and user safety.
4.2	Evaluate computational engineering solutions considering environmental, societal, and economic contexts.	Ensured the simulator's impact is assessed comprehensively.
5.1	Participate in the development and selection of ideas to meet established objective and goals.	Active participation in brainstorming and selecting ideas that align with established objectives and goals for the VR flight simulator.
5.2	Able to plan, share and execute task responsibilities to function effectively by creating collaborative and inclusive environment in a team.	Collaborative task planning and execution to foster an inclusive environment within a team, ensuring effective functioning and contribution toward the simulator's development.
6.1	Ability to perform experimentations and further analyze the obtained results.	Conducted experiments to refine and improve the simulator's performance and user experience.
6.2	Ability to analyze and interpre data, make necessary judgement(s and draw conclusion(s).	Proficiently analyzing data gathered from simulations making informed judgments and drawing conclusions to enhance the simulator.
7.1	Able to explore and utilize resources to enhance self-learning.	Encouraged self-learning by exploring and utilizing various resources to expand knowledge in areas related to virtual reality technologies.

7.7 Brief Analytical Assessment

1. Project Objectives and Scope:

Evaluation of Goals: The project aimed to develop an immersive VR flight simulator to provide realistic flight experiences. Objectives were well-defined, aligning with the creation of a user-friendly, educational, and entertaining simulator.

Scope Review: The project scope encompassed aircraft control, flight dynamics, environment realism, and user interaction, effectively covering essential elements.

2. Technical Performance:

Functionality and User Experience: The VR simulator showcased commendable functionality, providing an engaging and immersive experience for users. Controls were intuitive, and the simulated environment was realistic, contributing to a captivating user experience.

3. Development Process:

Methodologies Used: Agile methodologies were employed, facilitating iterative development and adaptation to evolving requirements. This allowed for flexibility and responsiveness to user feedback.

Team Collaboration: The team exhibited strong collaboration, effective communication, and a well-structured workflow, resulting in efficient development processes.

4. Technical Challenges and Solutions:

Identified Challenges: Technical challenges included optimizing performance across different VR hardware configurations and achieving a balance between realism and performance.

Solutions Implemented: These challenges were addressed through adaptive rendering techniques and iterative adjustments in the simulator's settings, ensuring a smoother user experience.

5. Project Management:

Timeline Adherence: The project adhered well to the outlined timelines, meeting major milestones within specified deadlines.

Resource Management: Efficient allocation and utilization of resources ensured minimal wastage and maximized productivity throughout the project.

APPENDIX A: REFERENCES

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APPENDIX B: PLAGIARISM REPORT