VISVESVARAYA TECHNOLOGICAL UNIVERSITY
BELAGAVI

Mini Project Report on

"STUNT PLANE SIMULATION"

Submitted in the partial fulfillment for the requirements of Computer Graphics & Visualization Laboratory of 6th semester CSE requirement in the form of the Mini Project work

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CERTIFICATE

This is to certify that the Project work entitled **“STUNT PLANE PROJECT”** is a Bonafide work carried out by **Jaya Surya G (1BY20CS073) ,K Prajwal Reddy (1BY20CS077), and P S Sai Teja (1BY20CS132)** in partial fulfillment for *Mini Project* during the year 2022-2023. It is hereby certified that this project covers the concepts of *Computer Graphics & Visualization*.It so certified that all corrections/suggestions indicated for Internal Asses haven incorporated in this report.

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3. Exhibit professional and team building attitude along with effective communication.
4. Identify and provide solutions for sustainable environmental development.

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ABSTRACT

The above program is a graphical simulation of a stunt plane created using OpenGL. It uses GLUT (OpenGL Utility Toolkit) library for handling windows and input events.

The above program is a graphical simulation of a stunt plane created using OpenGL. It uses GLUT (OpenGL Utility Toolkit) library for handling windows and input events.

The program begins by including the necessary header files and defining various global variables to store the state of the plane, such as its position, rotation, and movement. It also includes functions for drawing the plane, obstacles, and other graphical elements.

The main function initializes the GLUT library and sets up the window and display properties. It defines various callback functions for handling keyboard input and special keys. The program uses the idle function to continuously update the display and create animation effects.

The program provides functionality to control the plane's movement using the 'w', 'a', 's', and 'd' keys, allowing the user to move the plane up, down, left, and right respectively. Pressing the 'p' key increases the x-coordinate of the plane, and pressing the 'o' key decreases it. Pressing the 'q' key exits the program.

The program also includes a gameOver() function to display a message when the plane crashes. It uses the stroke_output() function to render text on the screen.

Overall, the program creates a 3D visualization of a stunt plane and allows the user to control its movement in a virtual environment.

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Chapter 1

INTRODUCTION

COMPUTER GRAPHICS

Graphics provides one of the most natural means of communicating with a computer, since our highly developed 2D and 3D pattern-recognition abilities allow us to perceive and process pictorial data rapidly and efficiently. Interactive computer graphics is the most important means of producing pictures since the invention of photography and television. It has the added advantage that, with the computer, we can make pictures not only of concrete real world objects but also of abstract, synthetic objects, such as mathematical surfaces and of data that have no inherent geometry, such as survey results.

Using this editor you can draw and paint using the mouse. It can also perform a host of other functions like drawing lines, circles, polygons and so on. Interactive picture construction techniques such as basic positioning methods, rubber-band methods, dragging and drawing are used. Block operations like cut, copy and paste are supported to edit large areas of the workspace simultaneously. It is user friendly and intuitive to use.

OpenGL(open graphics library) is a standard specification defining a cross language cross platform API for writing applications that produce 2D and 3D computer graphics. The interface consists of over 250 different function calls which can be used to draw complex 3D scenes from simple primitives. OpenGL was developed by silicon graphics Inc.(SGI) in 1992 and is widely used in CAD ,virtual reality , scientific visualization , information visualization and flight simulation. It is also used in video games, where it competes with direct 3D on Microsoft Windows platforms.OpenGL is managed by the non-profit technology consortium, the khronos group, Inc

OpenGL serves two main purpose :

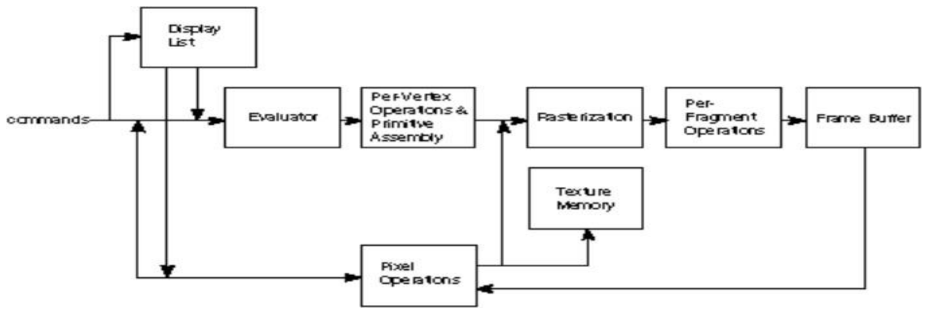
- To hide the complexities of interfacing with different 3D accelerators, by presenting programmer with a single, uniform API
- To hide the differing capabilities of hardware platforms, by requiring that all Implementations support the full openGL, feature set.

OpenGL has historically been influential on the development of 3D accelerator, promoting a base level of functionality that is now common in consumer level hardware:

- Rasterized points, lines and polygons are basic primitives.
- A transform and lighting pipeline.
- Z buffering.
- Texture Mapping.
- Alpha
- Blending.

OPEN-GL

OpenGL serves as an interface between software applications and graphics hardware, enabling developers to harness the full potential of the underlying graphics processing unit (GPU). It offers a comprehensive set of functions and commands for tasks such as geometry transformations, lighting and shading, texture mapping, and rasterization. These capabilities empower developers to create highly realistic and immersive graphics environments across a wide range of platforms, including desktop computers, mobile devices, game consoles, and embedded systems. The flexibility and extensibility of OpenGL have led to its adoption in various industries and applications



Creating realistic and visually appealing 3D environments is a fascinating aspect of computer graphics. One popular application of 3D graphics is the design and visualization of interior spaces, such as bedrooms. This report explores the process of creating a 3D house environment, utilizing computer graphics techniques to bring virtual spaces to life.

The design of a bedroom involves careful consideration of elements such as furniture placement, lighting, materials, and aesthetics. With the help of 3D graphics, designers and architects can create virtual representations of bedrooms that provide a realistic preview of the final space. This allows for experimentation with different layouts, colours, and styles, enabling informed decision-making and effective communication with clients.

In the realm of computer graphics, the creation of a 3D house environment involves several key components. These include 3D modelling, which involves the creation of virtual objects and furniture that populate the bedroom scene. Texturing adds visual details and materials to these objects, enhancing their realism. Lighting plays a crucial role in setting the mood and atmosphere of the bedroom, replicating the behaviour of light sources in the virtual environment. Finally, rendering techniques are employed to generate the final high-quality images or animations of the 3D house scene

.

The utilization of computer graphics in the design and visualization of bedrooms offers numerous advantages. Designers can experiment with various layouts and configurations, exploring different furniture arrangements and colour schemes to achieve the desired ambiance. Clients can also visualize their future bedrooms in a realistic manner, providing them with a tangible understanding of the design concepts and aiding in the decision-making process. Additionally, 3D house visualizations offer a cost-effective alternative to physical prototypes or full-scale room mock-ups. By utilizing virtual environments, designers can explore various design options, experiment with different styles and configurations, and iterate quickly without incurring substantial expenses.

Moreover, 3D house visualizations can provide a platform for immersive experiences. Virtual reality (VR) technology allows users to step into a virtual bedroom, where they can interact with objects, change materials, and experience different lighting scenarios. This immersive approach provides a unique and engaging way to showcase bedroom designs to clients or potential buyers.

1.2 MOTIVATION

The motivation behind developing the stunt plane project lies in the fascination and excitement associated with flight simulation and the world of aviation. Flight simulations allow individuals to experience the thrill of piloting an aircraft without the associated risks and costs. By creating a 3D environment where users can control a stunt plane, this project aims to provide an immersive and entertaining experience.

1. **Educational Value:** Flight simulations have educational benefits, allowing users to understand the principles of flight, aircraft controls, and navigation. By creating a visually appealing and interactive application, users can gain a basic understanding of aircraft maneuvering and control.

2. **Entertainment:** Flight simulations have long been popular among aviation enthusiasts and gamers. By developing a visually appealing and interactive stunt plane simulation, the project aims to provide entertainment for users who enjoy virtual experiences and challenges.

3. **Skill Development**: Developing a project like this involves working with computer graphics, implementing user interactions, handling transformations, and collision detection. By undertaking this project, individuals can enhance their programming skills, particularly in the fields of computer graphics, game development, and simulation.

4. **Creativity and Innovation**: The project provides an opportunity to explore creative design choices, such as creating a realistic 3D environment, modeling a stunt plane, and designing obstacles. It encourages innovative thinking and problem-solving to create an engaging and visually appealing experience.

5. **Personal Interest**: The project may stem from a personal interest in aviation, computer graphics, or game development. By combining these interests, individuals can create a project that aligns with their passions and allows them to explore a specific area of interest in more depth.

Overall, the motivation behind this project lies in the desire to create an engaging and interactive flight simulation experience that combines entertainment, education, and personal interest.

1.3 SCOPE

The scope of the stunt plane project involves developing a 3D stunt plane simulation with a range of features and functionalities. Here are some key aspects of the project's scope:

1. Stunt Plane Model: Create a realistic 3D model of a stunt plane, including accurate geometry, textures, and animations. The model should replicate the appearance and behavior of a real stunt plane.

2. 3D Environment: Design and develop a visually appealing 3D environment for the simulation. This environment should include a variety of terrains, such as mountains, valleys, and open fields, to provide a diverse flying experience.

3. User Controls: Implement user controls for the stunt plane, allowing users to manipulate the plane's movements, including pitch, roll, and yaw. The controls should be intuitive and responsive, providing a realistic flying experience.

4. Flight Physics: Incorporate realistic flight physics to simulate the behavior of the stunt plane. This includes factors such as gravity, wind resistance, aerodynamics, and engine performance. Accurate physics will contribute to a more immersive and authentic experience.

5. Stunt Challenges: Design and implement various stunt challenges for the user to complete. These challenges may involve tasks such as flying through hoops, performing acrobatic maneuvers, or navigating obstacle courses. Each challenge should provide a level of difficulty and require skillful piloting.

6. Scoring and Progression: Develop a scoring system to track the user's performance in completing the stunt challenges. Provide feedback to the user on their score, time taken, and any penalties incurred. Allow users to progress through different levels or unlock new challenges as they successfully complete previous ones.

9. Optimization and Performance: Optimize the code and assets to ensure smooth performance and responsiveness of the simulation, even on lower-end hardware. Consider techniques such as level of detail (LOD) rendering and resource management to achieve optimal performance.

10. Platform Compatibility: Make the simulation compatible with different platforms, such as desktop computers, gaming consoles, or virtual reality (VR) devices. This may require adapting the controls, graphics settings, and user interface to suit the target platform.

11. Documentation and Testing: Provide comprehensive documentation that explains the functionality, features, and usage of the simulation. Conduct thorough testing to identify and resolve any bugs, glitches, or performance issues to ensure a stable and reliable user experience.

It's important to note that the scope of the project can be adjusted based on the available time, resources, and desired level of complexity. The above points serve as a starting point for the project's scope and can be expanded or refined as per the specific goals and requirements of the development team.

1.4 PROBLEM STATEMENT

Develop a computer graphics application using C++ and OpenGL that simulates a stunt plane flying through a 3D environment. The objective is to create an interactive experience where the user can control the movement of the plane and navigate it through obstacles.

Requirements:

1. Create a 3D environment with a sky background and a ground surface.
2. Implement a stunt plane model with a main body, fins, tail, wheels, and rotating blades.
3. Allow the user to control the plane using keyboard inputs:
   - 'a' and 'd' keys should tilt the plane left and right.
   - 'w' key should move the plane forward.
   - Arrow keys should adjust the plane's pitch.
   - 's' key should initiate continuous movement of the plane.
4. Implement transformations to animate the movement of the plane, including rotation, translation, and scaling.

5. Display obstacles represented by solid torus objects in the environment.
6. Implement collision detection between the plane and obstacles.
7. When a collision occurs, display a "Game Over" screen indicating that the plane has crashed.
8. Provide a user-friendly interface and intuitive controls for a seamless user experience.
9. Ensure smooth rendering and realistic movement of the plane.
10. Write clean and well-structured code with proper comments and documentation.
11. Optimize the program for efficiency and performance.
12. Test the application thoroughly to ensure stability and correctness.

Note: The objective of this project is to create a basic flight simulation application using computer graphics techniques and OpenGL. The focus should be on implementing the necessary features and providing an enjoyable user experience rather than aiming for advanced realism or complex physics simulations.

1.5 PROPOSED METHODOLOGY

The system will consist of the following key components:

1. Requirement Analysis: Begin by understanding the project's objectives, target audience, and desired features. Identify the core functionalities, such as plane controls, stunt challenges, and scoring system. Gather requirements from stakeholders and define the scope of the project.

2. Design and Planning: Create a high-level architectural design for the project, considering factors like 3D modeling, physics simulation, user interface, and game mechanics. Break down the development process into smaller tasks and establish a timeline for each phase. Plan resource allocation, including team members, software, and hardware requirements.

3. 3D Modeling and Environment Design: Start by developing the 3D model of the stunt plane, ensuring accurate geometry, textures, and animations. Create the 3D environment, including terrains, obstacles, and landmarks. Utilize 3D modeling software and tools to bring the virtual world to life**.**

4. Flight Physics Implementation: Implement realistic flight physics to simulate the aerodynamics. Use mathematical equations and algorithms to calculate and update the plane'sposition and orientation based on user input and environmental conditions.

5. User Controls and Input Handling: Develop user controls that allow intuitive manipulation of the stunt plane's movements. Implement input handling mechanisms to process user input from various devices, such as keyboards, gamepads, or motion controllers. Ensure responsiveness and smooth control of the plane.

6. Stunt Challenges and Scoring System: Design and implement a variety of stunt challenges for the users to complete. Define the criteria for successfully completing each challenge and calculate the user's score based on performance. Incorporate a scoring system that considers factors like time taken, precision, and penalties.

7. Visual Effects and Sound Implementation: Enhance the simulation with visually appealing effects like smoke trails, particle effects, and realistic lighting. Implement sound effects to provide an immersive experience, including engine sounds, wind, and environmental audio. Use appropriate graphics and audio libraries or engines to achieve the desired effects.

1.6 LIMITATIONS

1. Hardware Requirements: The program may require a relatively powerful computer or gaming system to run smoothly, especially if it includes advanced graphics, physics simulation, and visual effects. Older or low-spec machines may experience performance issues or be unable to run the simulation at all.

2. Platform Specificity: The program may be designed for a specific platform or operating system, limiting its availability to users on other platforms. For example, if it is developed exclusively for Windows, users with Mac or Linux systems may not be able to run the simulation without compatibility issues or additional software.

3. Learning Curve: The simulation may have a learning curve, especially for users who are not familiar with flight simulation games or have limited experience with gaming **controls.** New users may require some time to understand the controls, physics, and gameplay mechanics, which could affect their initial experience.

4. Realism Constraints: While efforts may be made to create a realistic stunt plane simulation, there may be limitations in achieving complete realism. Factors such as physics simulation, environmental effects, and control responsiveness may not perfectly mirror real-life conditions due to the complexities involved or hardware limitations.

5. Content and Variety: Depending on the scope and resources available, the simulation may have limitations in terms of the number and diversity of stunt challenges, environments, and planes. Users may eventually exhaust the available content, reducing replay value and long-term engagement.

CHAPTER 2

LITERATURE SURVEY

Computer graphics started with the display of data on hardcopy plotters and cathode ray tube (CRT) screens soon after the introduction of computers.

Computer graphics today largely interactive, the user controls the contents, structure, and appearance of objects and of displayed images by using input devices, such as keyboard, mouse, or touch-sensitive panel on the screen. Graphics based user interfaces allow millions of new users to control simple, low-cost application programs, such as spreadsheets, word processors, and drawing programs.

OpenGL (Open Graphics Library) is a standard specification defining a crosslanguage, cross-platform API for writing applications that produce 2D and 3D computer graphics. The interface consists of over 250 different function calls which can be used to draw complex three-dimensional scenes from simple primitives. OpenGL was developed by Silicon Graphics Inc. (SGI) in 1992 and is widely used in CAD, virtual reality, scientific visualization, information visualization, and flight simulation. It is also used in video games, where it competes with Direct3D on Microsoft Windows platforms (see Direct3D vs. OpenGL). OpenGL is managed by the non-profit technology consortium, the Khronos Group.

In the 1980s, developing software that could function with a wide range of graphics hardware was a real challenge. By the early 1990s, Silicon Graphics (SGI) was a leader in 3D graphics for workstations. SGI's competitors (including Sun Microsystems, Hewlett-Packard and IBM) were also able. In addition, SGI had a large number of software customers; by changing to the OpenGL API they planned to keep their customers locked onto SGI (and IBM) hardware for a few years while market support for OpenGL matured to bring to market 3D hardware, supported by extensions made to the PHIGS standard. In 1992, SGI led the creation of the OpenGL architectural review board (OpenGL ARB), the group of companies that would maintain and expand the

OpenGL specification took for years to come. On 17 December 1997, Microsoft and SGI initiated the Fahrenheit project, which was a joint effort with the goal of unifying the

OpenGL and Direct3D interfaces (and adding a scene-graph API too). In 1998 HewlettPackard joined the project.[4] It initially showed some promise of bringing order to the world of interactive 3D computer graphics APIs, but on account of financial constraints at SGI, strategic reasons at Microsoft, and general lack of industry support, it was abandoned in 1999[8].

Many opengl functions are used for rendering and transformation purposes. Transformations functions like glRotate (), glTranslate (), glScaled () can be used.

OpenGL provides a powerful but primitive set of rendering command, and all higherlevel drawing must be done in terms of these commands. There are several libraries that allow you to simplify your programming tasks, including the following:

OpenGL Utility Library (GLU) contains several routines that use lower-level OpenGL commands to perform such tasks as setting up matrices for specific viewing orientations and projections and rendering surfaces.

OpenGL Utility Toolkit (GLUT) is a window-system-independent toolkit, written by Mark Kill guard, to hide the complexities of differing window APIs.

To achieve the objective of the project, information related to the light sources is required with OpenGL we can manipulate the lighting and objects in a scene to create many different kinds of effects. It explains how to control the lighting in a scene, discusses the OpenGL conceptual model of lighting, and describes in detail how to set the numerous illumination parameters to achieve certain effects. This concept is being obtained from.

To demonstrate the transformation and lightening, effects, different polygons have to be used. Polygons are typically drawn by filling in all the pixels enclosed within the boundary, but we can also draw them as outlined polygons or simply as points at the vertices.

This concept is obtained from.

The properties of a light source like its material, diffuse, emissive, has to mention in the project. So to design the light source and the objects, programming guide of an OpenGL is used.

CHAPTER 3

SYSTEM REQUIREMENTS

HARDWARE REQUIREMENTS

- **Operating System**: Unix, Linux, Mac, Windows etc.
- **Processor**: Pentium or Higher.
- **RAM:** 312MB or Higher.
- 14”monitor
- **Keyboard and mouse**

SOFTWARE REQUIREMENTS

- **Programming language---**C/C++ using OpenGL
- **Operating system** – – Windows/Linux
- **Compiler** – C/C++ Compiler
- **IDE** – Code blocks

Functional Requirement – <GL/glut.h>

CHAPTER 4

IMPLEMENTATION

Several OpenGL functions are used to create and render the windmill simulation. Here are the main OpenGL functions used in the code:

- glClear(): This function is used to clear the color buffer and depth buffer of the current OpenGL rendering context.

- glMatrixMode() and glLoadIdentity(): These functions are used to specify and manipulate the current matrix mode (projection or model view) and load the identity matrix into the current matrix stack.

- glEnable(): This function is used to enable various capabilities or features in OpenGL, such as lighting, texturing, and depth testing.

- glViewport(): This function sets the viewport parameters, which determines the mapping of normalized device coordinates to the window coordinates.

- glOrtho(): This function sets up an orthographic projection matrix, defining the viewing volume for the scene.

- glBegin() and glEnd(): These functions delimit the vertices of a primitive or geometric shape, such as points, lines, or polygons.

- glVertex3f(): This function specifies a 3D vertex position for the current primitive being defined.

- glColor3f(): This function sets the current color for subsequent vertices or objects.

- glRotatef(): This function applies a rotation transformation to the current matrix stack.

- glTranslate(): This function applies a translation transformation to the current matrix stack.

- gluNewQuadric(), gluQuadricDrawStyle(), gluQuadricNormals() and gluQuadricOrientation(): These functions are part of the GLU (OpenGL Utility Library) and are used to create and configure a quadric object, which is used to draw cylinders and cones in the windmill simulation.

glLightfv(): This function sets the parameters of a light source, such as its position and color.

glMaterialfv(): This function sets the material properties for lighting calculations, including ambient, diffuse, specular, and shininess values.

glPushMatrix() and glPopMatrix(): These functions save and restore the current matrix transformation state from the matrix stack.

glutCreateMenu(), glutAddMenuEntry(), and glutAttachMenu(): These functions are part of the GLUT (OpenGL Utility Toolkit) library and are used to create and manage a menu for selecting different views in the windmill simulation.

glutInit() : interaction between the windowing system and OPENGL is initiated

glutInitDisplayMode() : used when double buffering is required and depth information is required

glutCreateWindow() : this opens the OPENGL window and displays the title at top of the window

glutInitWindowSize() : specifies the size of the window

glutInitWindowPosition() : specifies the position of the window in screen co-ordinates

glutReshapeFunc() : sets up the callback function for reshaping the window

glutIdleFunc() : this handles the processing of the background

glutDisplayFunc() : this handles redrawing of the window

glutMainLoop() : this starts the main loop, it never returns

CHAPTER 4

INTERPRETATION OF RESULTS

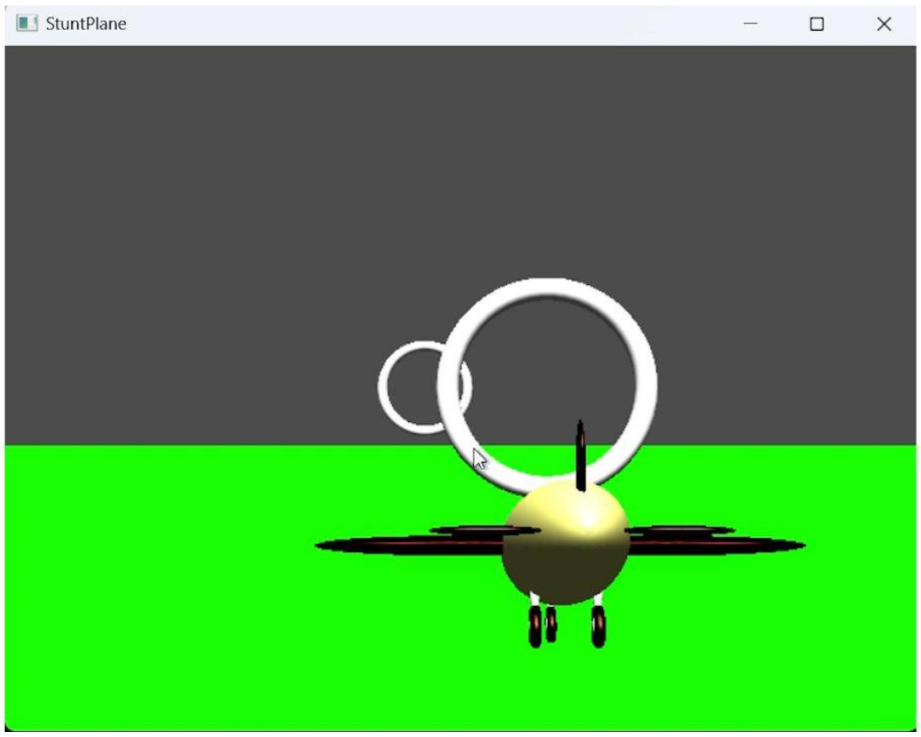


Figure 6.1 .Plane started on clicking S

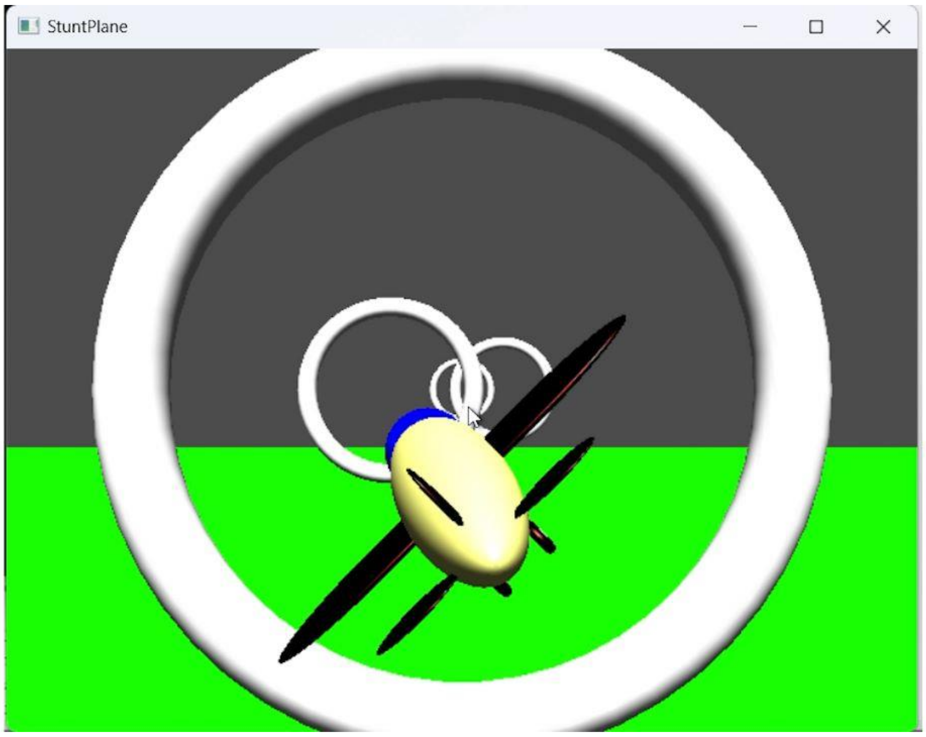


Figure 6.2 After clicking left(<-) or A

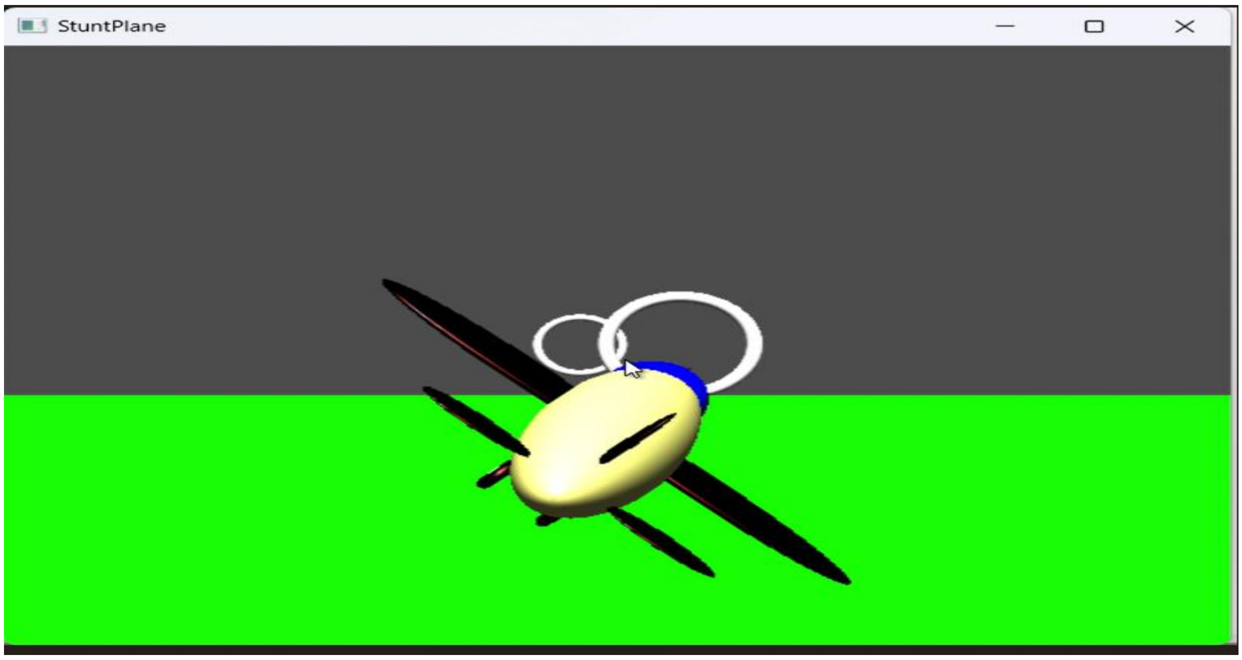


Figure 6.3 after clicking right(->) or D

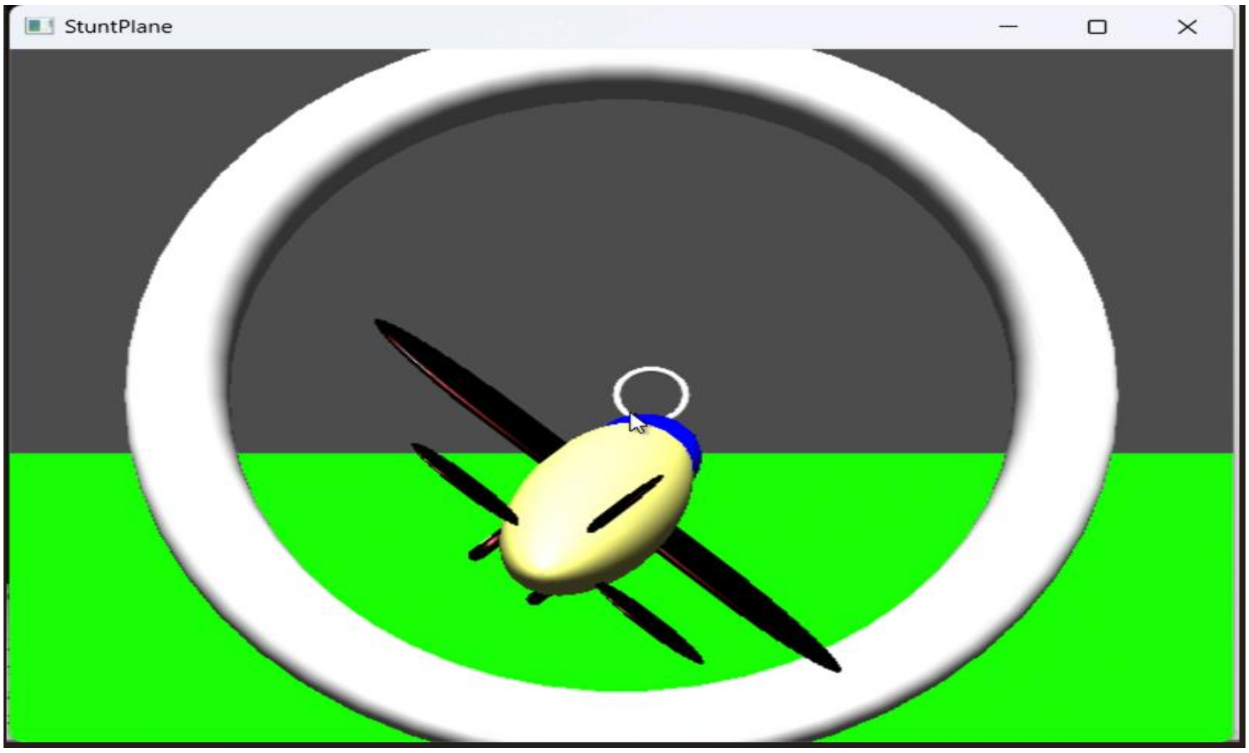


Figure 6.4 Plane passing through the circles

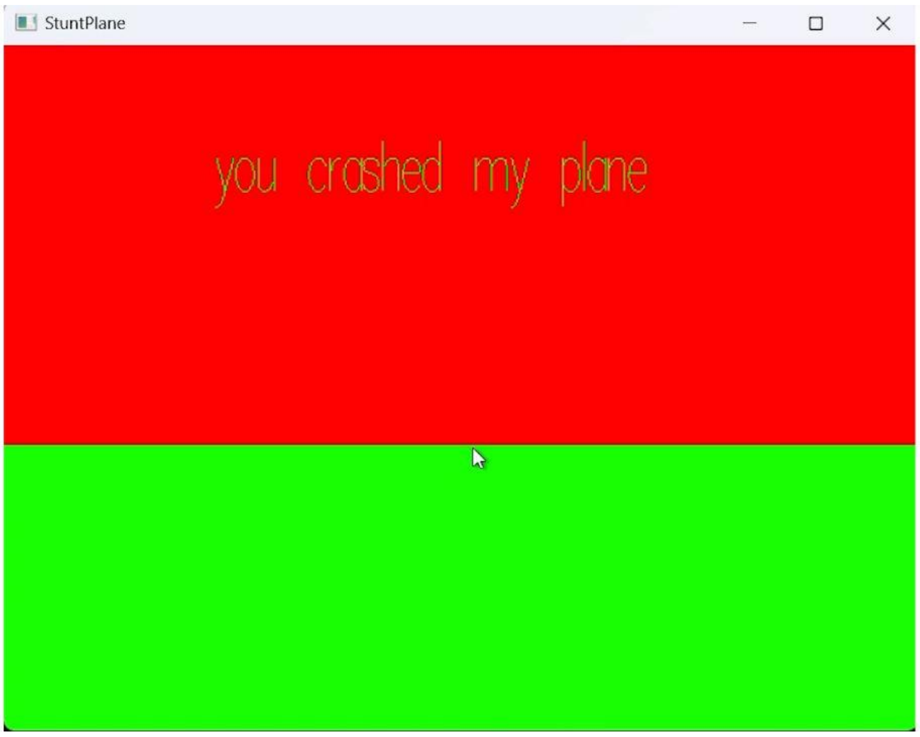


Figure 6.5 After crashing the plane press Q to quit

Chapter 5

CONCLUSION

In conclusion, the Stunt Plane Simulation Program offers an immersive and thrilling experience for aviation enthusiasts and gamers alike. It provides a platform for users to simulate and enjoy the excitement of performing daring stunts in a virtual environment. The program's proposed methodology focuses on realistic physics simulation, engaging gameplay mechanics, and visually appealing graphics to enhance the user experience.

However, it is important to consider the limitations of the program. These include hardware requirements, platform specificity, a learning curve for new users, constraints on achieving complete realism, limitations in content variety, potential multiplayer issues, support and updates, accessibility considerations, language and localization challenges, and security and privacy concerns.

Despite these limitations, the program holds great potential for entertainment, skill development, and even educational purposes. By continuously addressing and improving upon these limitations, the Stunt Plane Simulation Program can provide an engaging and enjoyable experience for users, fostering a sense of adventure and excitement in the world of aviation.

FUTURE ENHANCEMENTS

There are several potential future enhancements that can be considered for the Stunt Plane Simulation Program:

1. Expanded Stunt Variety: Introduce a wider range of stunts and maneuvers for players to perform, including more complex aerial tricks, formations, and challenges. This can increase the replay value and offer a greater sense of achievement for skilled players.

2. Multiplayer Functionality: Implement a multiplayer mode where players can compete or collaborate with others in performing stunts, organizing air shows, or participating in challenges. This can add a social aspect to the program and enhance the overall experience.

3. More Realistic Physics Simulation: Continuously improve the physics engine to provide even more realistic flight dynamics, aerodynamics, and collision detection. This will create a more immersive experience and enhance the authenticity of the stunts performed.

4. Enhanced Graphics and Visual Effects: Upgrade the program's graphics engine to deliver stunning visuals, realistic environments, and special effects such as dynamic weather conditions, particle effects, and advanced lighting techniques. This can create a more visually appealing and immersive experience.

5. Customization Options: Introduce a system that allows players to customize their stunt planes with different paint schemes, decals, and performance upgrades. This personalization can enhance player engagement and provide a sense of ownership over their virtual aircraft.

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