A PROJECT BASED LEARNING-II REPORT ON

AI AND DS LAB VIRTUAL EXPLORATION

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OF

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CERTIFICATE

This is to certify that the SPPU Curriculum-based Project Based Learning-II report entitled

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ABSTRACT

Virtual Reality (VR) has emerged as a transformative technology with immense potential for education and training. In this context, the development of a 3D model for a computer lab using Blender and its integration into a Unity project for VR aims to create an immersive learning environment that simulates a real-world computer lab setting. This project leverages the capabilities of Blender for 3D modeling and Unity for VR development to provide users with a realistic and interactive experience. The development of a 3D model for a computer lab using Blender and Unity project for VR represents a significant advancement in immersive education and training. By leveraging VR technology, users can access a virtual computer lab environment from anywhere, at any time, overcoming the limitations of physical infrastructure and enhancing accessibility. This project opens up new possibilities for interactive learning experiences, fostering engagement, collaboration, and skill acquisition in the field of computer science and technology.

Keywords: Virtual Reality (VR), 3D Modelling, Virtual Lab, Education and training, Accessibility, Engagement, Collaboration

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LIST OF ABBREVATIONS

3D	3 Dimensional
VR	Virtual Reality
AR	Augmented Reality
CAD	Computer Aided Design
BSDF	Bidirectional Scattering Distribution Function
HTC	High Tech Computer
FBX	Filmbox
OBJ	Object

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION TO 3D MODELLING AND VR

In today's digital age, computer labs serve as vital spaces for education, research, and professional development. These environments are not merely collections of hardware and furniture but dynamic hubs where individuals interact with technology to acquire knowledge and skills. As technology continues to advance, there is a growing need for innovative approaches to design and visualize computer lab environments, enhancing their functionality and educational value.

This project focuses on the development of a three-dimensional (3D) model for a computer lab environment using Blender for modeling and Unity for interactive visualization. By leveraging these powerful tools, we aim to create an immersive and interactive representation of a computer lab that goes beyond traditional static renderings.

The significance of this project lies in its potential to revolutionize the way computer labs are conceptualized and utilized in educational and professional contexts. By providing a realistic and dynamic virtual environment, our 3D model offers unique opportunities for learning, training, and collaboration.

Furthermore, VR-based learning environments have the potential to enhance accessibility and inclusivity by accommodating diverse learning styles and preferences. Individuals with physical disabilities or limitations, as well as those located in remote areas, can benefit from the flexibility and accessibility offered by VR technology.

1.2 MOTIVATION

1. **Enhancing Educational Resources:** Traditional methods of learning often rely on static images or verbal descriptions to convey complex concepts related to computer hardware, ergonomics, and workspace organization. By developing a 3D model of a computer lab, we aim to provide educators and learners with a dynamic and immersive educational resource that fosters better understanding and retention of essential information.

2. **Bridging the Gap Between Theory and Practice:** Many educational programs emphasize theoretical knowledge without providing sufficient opportunities for practical application. Through the creation of a realistic virtual computer lab environment, learners can explore concepts such as ergonomic workstation setup, cable management, and equipment configuration in a hands-on manner, bridging the gap between theory and practice.

3. **Promoting Accessibility and Inclusivity:** Physical limitations or logistical constraints may prevent individuals from accessing traditional computer lab facilities. By offering a virtual representation of a computer lab, we can make educational resources more accessible to a broader audience, including individuals with disabilities or those located in remote areas.

4. **Fostering Innovation and Creativity:** Blender and Unity are powerful tools that enable users to unleash their creativity and bring their ideas to life in the digital realm. By leveraging these tools to develop a 3D model of a computer lab, we aim to inspire innovation and creativity in the fields of computer-aided design, visualization, and educational technology.

5. **Addressing Emerging Educational Trends:** As technology continues to evolve, so too do the methods and tools used in education. Virtual reality (VR) and augmented reality (AR) technologies are increasingly being integrated into educational settings to create immersive learning experiences. By exploring the potential of Blender and Unity in this context, we can stay ahead of the curve and adapt to emerging educational trends.

1.3 PROBLEM STATEMENT

"The current state of computer lab environments in educational settings lacks immersion, interactivity, and accessibility, hindering students' ability to fully engage with and understand concepts related to computer hardware and software. There is a need for a realistic and immersive VR-based solution that accurately replicates the functionality and atmosphere of a real-world computer lab while addressing accessibility issues and providing opportunities for hands-on learning and exploration."

Addressing this problem requires the development of a comprehensive VR-based 3D model for a computer lab using Blender and Unity, which provides students with a realistic and interactive learning environment that enhances their understanding and engagement with computer-related concepts. This project seeks to bridge the gap between traditional educational methods and emerging VR technologies, empowering students to succeed in an increasingly digital world

CHAPTER 2

LITERATURE SURVEY

2.1 EXISTING METHODOLOGIES

Sr no.	Book Name	Author	Description
1.	**"Digital Modeling of Shape: From Methodologies to CAD Systems" (2008)**	**Nikos S. Sapidis**	• This book provides a comprehensive overview of digital modeling techniques, methodologies, and CAD systems used in computer-aided design (CAD). • It covers fundamental concepts of geometric modeling, including parametric and non-parametric methods, surface reconstruction, and solid modeling techniques. • The book also discusses advanced topics such as geometric algorithms, shape optimization, and feature-based modeling.
2.	**"Polygonal Mesh Processing" (2010)**	**Botsch, Mario, and Leif Kobbelt (2010):**	• This book presents a collection of research papers on various aspects of polygonal mesh processing, a fundamental technique in 3D modeling. • It covers topics such as mesh generation, simplification, smoothing, deformation, segmentation, and remeshing, providing insights into state-of-the-art algorithms and methodologies. • The book also addresses practical applications of polygonal mesh processing in computer graphics, geometry processing, and computational biology.

3.	**"Procedural Content Generation in Games" (2016)**	**Noor Shaker, Julian Togelius, and Mark J. Nelson**	• This book explores the use of procedural content generation (PCG) techniques in game development, including 3D modeling. • It discusses various methodologies for generating game content algorithmically, such as terrain generation, texture synthesis, and procedural modeling of objects and characters. • The book also covers practical considerations and case studies of PCG techniques in popular game titles, highlighting their impact on game design and development.
4.	**"Advances in 3D Geo-Information Sciences" (2017)**	**Alias Abdul Rahman, Umit Isikdag, and Esra Ozdenerol**	• This book presents recent advances in 3D geo-information sciences, focusing on methodologies and applications related to geographic information systems (GIS) and spatial data modeling. • It covers topics such as 3D terrain modeling, urban modeling, indoor navigation, and 3D city modeling, showcasing state-of-the-art techniques and case studies from various domains. • The book also addresses emerging trends and challenges in 3D geo-information sciences, including data acquisition, processing, visualization, and interoperability.

Table 2.1.1 Existing Methodologies

2.2 SUMMARY OF LITERATURE SURVEY

Sr no.	Book Name	Author	Description
1.	**"Virtual Reality in Education: A Tool for Learning in the Experience Age" (2018)**	**Oliver T. Smith and Matthew B. Henderson**	provides an overview of VR technologies and their potential applications in education, including immersive learning environments, simulation-based training, and virtual field trips.
2.	**"Virtual Reality Enhanced Learning Environments: A Synthesis of Theory and Practice" (2018)**	**Ritchie S. King and John J. F. Forest**	explores theoretical frameworks and practical considerations for designing and implementing VR-enhanced learning environments, including pedagogical approaches, instructional design principles, and user engagement strategies.
3.	**"3D Modeling Techniques for Virtual Reality Applications" (2003)**	**Jung W. Suh and R. Bowen Loftin**	discusses various 3D modeling techniques and tools suitable for VR applications, including polygonal modeling, NURBS modeling, procedural modeling, and photogrammetry.
4.	**"Virtual Reality for Learning: A Hands-On Introduction to Virtual Reality in Education" (2019)**	**Michael P. Mauzey and Jay C. Shaffer**	explores practical applications of VR technology in education, including immersive simulations, virtual laboratories, and interactive learning environments.
5.	**"Enhancing Learning and Teaching through Student Generated Content"**	**Thomas Cochrane et al**	discusses the benefits of student-generated VR content for enhancing learning outcomes, fostering creativity, and promoting student engagement.
6.	**"Designing for Virtual Reality: A Design Thinking Approach"**	**Danielle Eubanks**	offers insights into user-centered design principles and methodologies for creating effective and engaging VR experiences,

			including usability testing, prototyping, and iteration.
7.	**Blender and Unity Tutorials and Documentation**		• Official documentation and tutorials for Blender and Unity offer valuable resources for learning the tools and techniques necessary for creating 3D models and VR experiences. These resources cover topics such as modeling, texturing, animation, scripting, and VR implementation, providing step-by-step guidance and best practices. • Community forums, online communities, and tutorial websites (e.g., Blender Artists, Unity Learn, CG Cookie) offer additional support and resources for users seeking to develop skills in 3D modeling and VR development with Blender and Unity.

Table 2.1.2 Summary of Literature Survey

CHAPTER 3

PLANNING AND SCHEDULING

3.1 SDLC MODEL

The Incremental Model was implemented in the project due to its iterative and modular nature. The project was divided into increments and then development was done accordingly. The increments were continuously improved and tested to improve the efficiency of the project. It is described below as follows:

1. **Requirements Gathering:**
    - Identifying the key requirements and objectives of the VR computer lab project, including the desired features, functionalities, and educational goals.
    - Breaking down the requirements into smaller, manageable increments that can be implemented sequentially.

2. **Increment Planning:**
    - Defining the scope and goals of each increment, specifying the features or functionalities to be implemented.
    - Prioritizing the increments based on their importance, complexity, and dependencies, ensuring that critical features are addressed first.

3. **Modeling in Blender:**
    - Starting with the foundational elements of the computer lab environment, such as walls, floors, and basic furniture.
    - Implementing each increment by adding additional details and components to the environment, such as computer desks, chairs, monitors, keyboards, and mice.
    - Iteratively refining and enhancing the models based on feedback and requirements.

4. **Unity Integration:**
    - Importing the Blender models into Unity and set up the VR environment, including camera placement, lighting, and scene composition.
    - Implementing VR interaction mechanics for navigating the environment, interacting with objects, and triggering events.

- Integrating each increment into the Unity project, ensuring that new features are seamlessly integrated with existing functionality.

5. **Testing and Feedback:**
    - Conducting regular testing and evaluation of the VR computer lab environment to identify bugs, usability issues, and areas for improvement.
    - Gathering feedback from stakeholders, including educators, students, and VR enthusiasts, to inform future iterations and refinements.

6. **Iterative Development:**
    - Iterating on the development process based on testing results and stakeholder feedback, making necessary adjustments and improvements to the VR environment.
    - Continuing implementing new features and increments iteratively, gradually building upon the existing foundation to achieve the desired level of functionality and realism.

7. **Documentation and Deployment:**
    - Documenting the development process, including the objectives, methodologies, and challenges encountered during each increment.
    - Preparing the final VR computer lab project for deployment on VR platforms, ensuring that it meets performance, usability, and educational requirements.

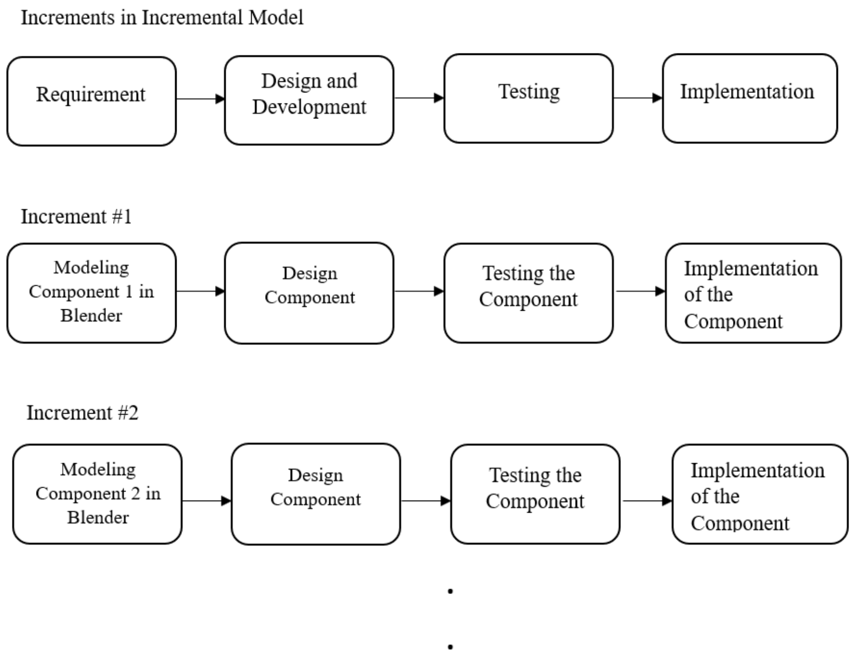

Fig no 3.1.1 Increments in Modeling

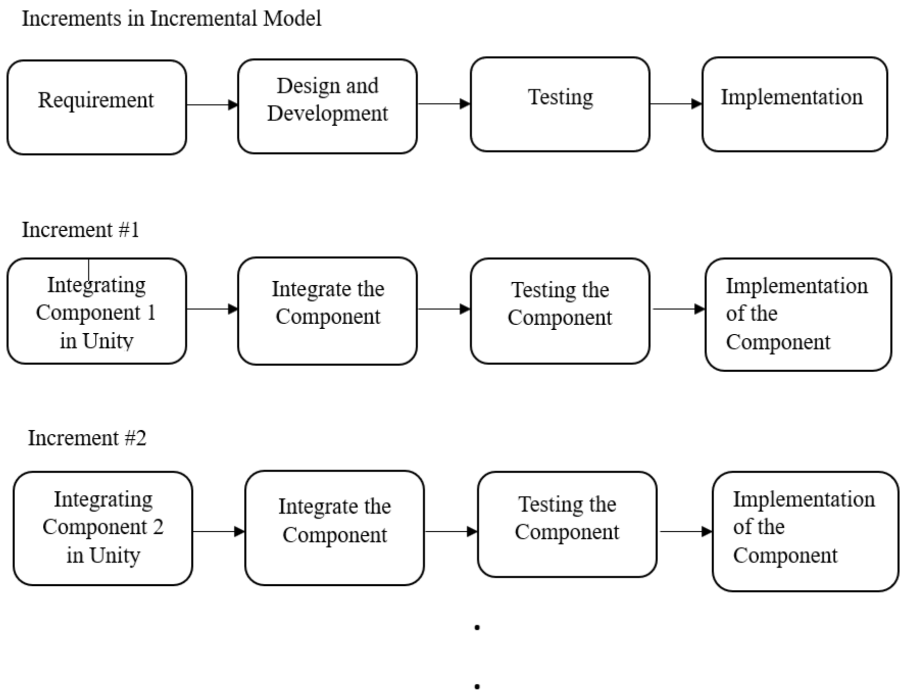

Fig no 3.1.2 Increments in Integration of Unity

3.2 GANTT CHART

Activities	12 Jan	19 Jan	2 Feb	9 Feb	16 Feb	23 Feb	1 March	15 March	30 March	3 April
Group Formation										
Mentor Allocation										
Problem Statement Selection										
Study of Project Objectives										
Requirement Analysis										
Literature Survey										
Study Blender for Modelling										
Taking measurements of the Lab										
Modeling of the Components										
Study Unity for interactivity										
Integrate Components in Unity										
Test the Components one by one in VR										

Table 3.2.1 Gantt Chart

CHAPTER 4
PROPOSED METHODOLOGY

4.1 METHODOLOGY USED

4.1.1 Blender

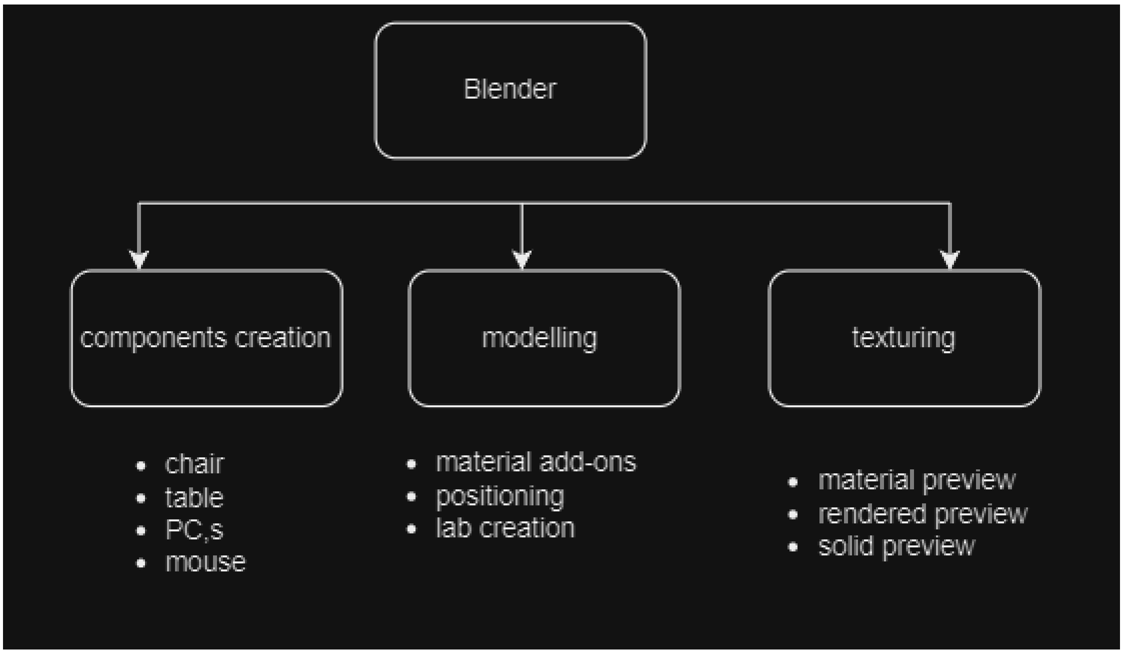

Fig no. 4.1.1.1 Blender Flowchart

1. Modeling Tools:

Blender offers a rich set of modeling tools that enable users to create and manipulate 3D geometry. These tools include functions for adding, editing, and transforming vertices, edges, and faces.

Steps:

- Launch Blender and select the default cube or press Shift+A to add a new primitive shape.
- Use the various selection tools (vertex select, edge select, face select) to select the desired components of the mesh.
- Manipulate the selected components using transformation tools such as Grab (G), Rotate (R), and Scale (S).
- Use the Extrude (E), Bevel (Ctrl+B), and Loop Cut (Ctrl+R) tools to add detail and complexity to the mesh.

2. Sculpting:

Blender's sculpting mode allows for intuitive and organic shaping of 3D models using brush-based tools. It is particularly useful for creating detailed and intricate surfaces.

Steps:

- Switch to Sculpt Mode by selecting it from the mode dropdown menu in the top-left corner of the 3D Viewport.
- Choose a sculpting brush from the Brush menu or the Brush panel.
- Use the brush to sculpt and deform the surface of the model. Left-click and drag to sculpt, and adjust the brush size and strength as needed.
- Experiment with different brushes and settings to achieve the desired shape and detail level.

3. UV Mapping and Texturing:

UV mapping is the process of unwrapping the 3D geometry of a model onto a 2D plane to apply textures accurately. Blender provides UV mapping tools and a Texture Paint mode for painting directly onto the model's surface.

Steps:

- Switch to Edit Mode and select the faces of the mesh you want to UV unwrap.
- Open the UV Editing workspace. Select UV > Unwrap > Unwrap from the top menu to generate UV coordinates for the selected faces.
- Switch to the Texture Paint workspace. Create a new texture and start painting directly onto the model using the available brushes and colors.
- Adjust the UV layout as needed to minimize distortion and optimize texture resolution.

4. UV Unwrapping:

Before adding textures, it's essential to UV unwrap the 3D model. UV unwrapping is the process of flattening the 3D geometry onto a 2D plane, allowing textures to be applied accurately.

To unwrap the model, switch to Edit Mode by pressing Tab or selecting it from the mode dropdown menu in the top-left corner of the 3D Viewport.

- Select the faces of the mesh you want to unwrap. You can use vertex, edge, or face select modes for this.
- Open the UV Editing workspace by selecting it from the workspace dropdown menu.
- In the UV Editing workspace, go to UV > Unwrap > Unwrap from the top menu to generate UV coordinates for the selected faces.
- Adjust the UV layout as needed to minimize distortion and optimize texture resolution. You can manually move and scale UV islands using the UV Editor.

5. Texture Painting:

Blender offers a Texture Paint mode that allows users to paint directly onto the surface of 3D models. This mode is useful for adding hand-painted details, colors, and textures to the model.

- Switch to Texture Paint mode by selecting it from the mode dropdown menu in the top-left corner of the 3D Viewport.
- Create a new texture for the model by opening the Texture Properties panel and clicking the "New" button. Adjust the texture settings such as size and format.
- Start painting directly onto the model using the available brushes and colors. You can adjust brush settings such as size, strength, and opacity in the Tool Shelf.
- Use different brushes and blending modes to add texture details like scratches, dirt, or patterns to the model's surface.

6. Image Texture Mapping:

Blender supports the use of image textures to add more complex and realistic surface details to 3D models. These textures can be applied using UV mapping or procedural methods.

- In the Shader Editor, add a new material to the model by clicking the "New" button. Connect the material output node to the surface input of the Principled BSDF shader.
- Add an Image Texture node by pressing Shift+A and selecting Texture > Image Texture. Open an image texture file from your computer by clicking the "Open" button in the node properties.
- Connect the color output of the Image Texture node to the Base Color input of the Principled BSDF shader. You can adjust the texture mapping coordinates and mapping projection in the Image Texture node properties.
- Repeat the process to add additional texture maps for other properties such as roughness, metallic, normal, and displacement.

7. Procedural Textures:

Blender also offers a variety of procedural textures that can be generated procedurally without the need for external image files. These textures can be applied to the model's surface using various shader nodes.

- In the Shader Editor, add a new material to the model and connect it to the surface input of the Principled BSDF shader.
- Add a Texture Coordinate node and connect it to the Vector input of the procedural texture node (e.g., Noise Texture, Voronoi Texture, or Musgrave Texture).
- Adjust the settings of the procedural texture node to control parameters such as scale, detail, and distortion. Connect the output of the procedural texture node to the desired input of the Principled BSDF shader (e.g., Base Color, Roughness, Normal).
- Experiment with different procedural textures and node setups to achieve the desired surface appearance and effects.

8. Modifiers:

Modifiers in Blender are non-destructive operations that can be applied to a mesh to alter its geometry. They enable users to perform a wide range of transformations and effects without permanently modifying the original mesh.

Steps:

- Select the object you want to apply a modifier to.
- Open the Modifiers tab in the Properties panel. Click the "Add Modifier" button to add a new modifier to the object.
- Choose the desired modifier from the list (e.g., Subdivision Surface, Mirror, Bevel) and adjust its settings as needed.
- Experiment with the modifier settings and stack multiple modifiers to achieve the desired effect. Use the visibility and ordering controls to adjust the stack order.

4.1.2 Unity

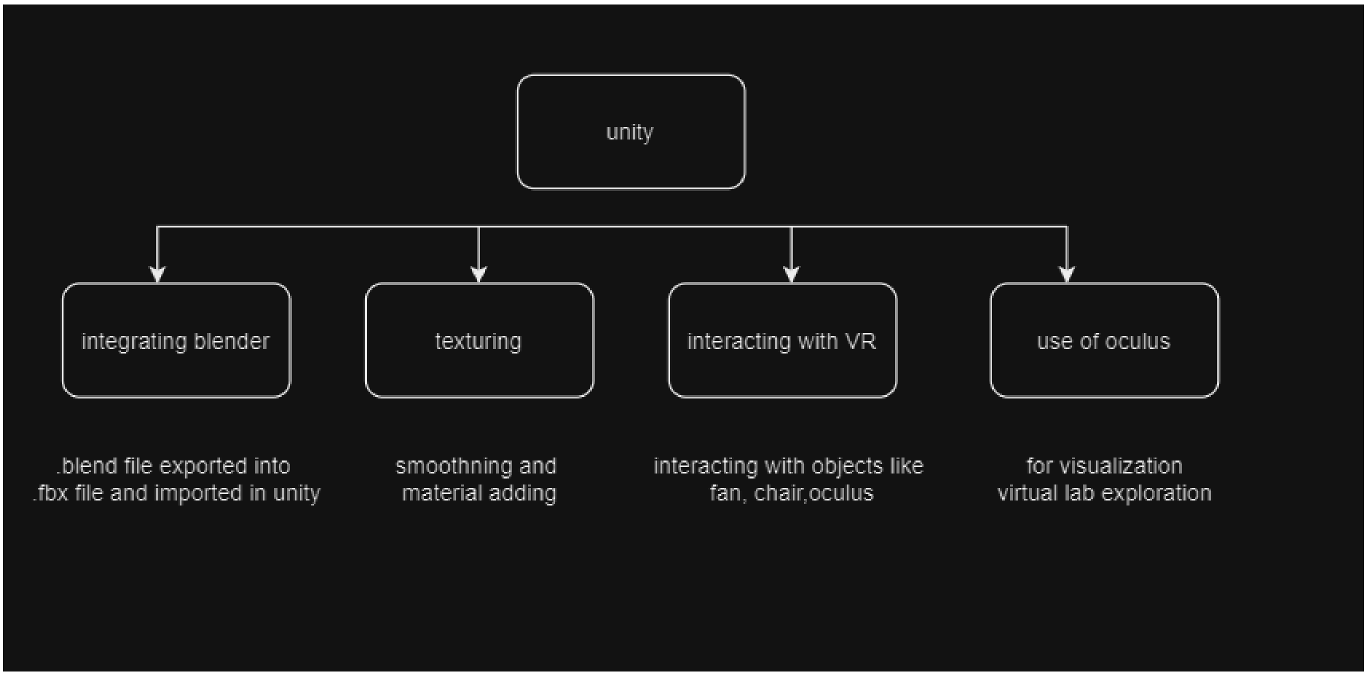

Fig no. 4.1.2.1 Unity Flowchart

1. **Importing the Model:**

- In Unity, go to Assets > Import Asset.
- Navigate to the location where you saved your exported Blender model (FBX or OBJ format).
- Select the model file and click Import.

2. **Setting Up the Scene:**

- Drag the imported classroom model from the Project window into the Hierarchy window to place it in your scene.
- You can adjust the position, rotation, and scale of the model using the inspector window.
- Consider using a Skybox material to create a background environment for your VR experience.

3. **Configuring the VR Camera:**

- Go to GameObject > Create Other > XR > Main Camera.
- This creates a camera specifically designed for VR experiences.
- In the inspector window, you can adjust properties like field of view, near and far clipping planes, and stereo convergence for better VR visuals.

4. **Locomotion System :**

- Unity offers various ways for users to move around in VR. You can choose from:
- Teleporting: Users can point and click on a location to teleport there. (This is a simple approach for beginners)
- Locomotion Controls: Implement controls (like using a VR controller joystick) for users to walk and turn within the VR environment. (Requires scripting knowledge

5. **Adding Interactivity :**

- You can add interactivity to your VR classroom by attaching scripts to objects within the scene.
- For example:
- Users might be able to pick up virtual objects within the classroom.
- Clicking on information points could display text or audio about specific elements.

6. **Building for VR:**

- Once you're happy with your VR scene, you can build it for your target VR platform (e.g., Oculus Quest, HTC Vive).
- Unity provides various build options depending on your chosen platform.

7. **Additional Considerations:**

- Lighting: Proper lighting is crucial for a visually appealing VR experience. Unity offers various lighting options like point lights, directional lights, and environment lighting.
- Performance Optimization: VR experiences require good performance to avoid nausea and discomfort. Optimize your scene by reducing the polygon count of your model and adjusting graphics settings.
- Testing: Test your VR classroom experience thoroughly to ensure smooth navigation, object interaction, and overall user experience.

CHAPTER 5

TESTING AND VALIDATION

1.1 VALIDATION AND TESTING

1. **Functional Testing:**

- Navigation: Ensure that users can navigate through the VR computer lab environment smoothly using VR controllers or other input devices. Test movement mechanics such as walking, teleporting, or grabbing and pulling objects.
- Interaction: Test interaction mechanics for interacting with objects in the computer lab, such as picking up items, opening doors, or using computer terminals. Verify that interactions are intuitive and responsive.
- UI and Menus: Test user interfaces and menus within the VR environment, including menus for selecting tools, adjusting settings, or accessing help and documentation. Ensure that menus are readable and easy to navigate in VR.
- Performance: Test the performance of the VR experience, including frame rate, loading times, and responsiveness. Identify any performance bottlenecks or issues that may affect the user experience.

2. **Visual Testing:**

- Model Quality: Inspect the quality of 3D models in the computer lab environment, including geometry, textures, materials, and lighting. Ensure that models are visually appealing and accurately represent real-world objects.
- Texturing and Materials: Verify that textures and materials are applied correctly and appear realistic in the VR environment. Check for texture seams, stretching, or other visual artifacts that may detract from the immersion.
- Lighting and Shadows: Evaluate the lighting and shadow effects in the VR environment, ensuring that lighting is realistic and appropriate for the scene. Test different lighting setups and adjust parameters to achieve the desired atmosphere.
- Scale and Proportions: Validate the scale and proportions of objects in the computer lab environment, ensuring that they match real-world dimensions. Use reference materials or measurements to verify accuracy.

3. Usability Testing:

- User Feedback: Gather feedback from users, including testers, stakeholders, and target users, on their experience with the VR computer lab environment. Identify any usability issues, pain points, or suggestions for improvement.
- User Comfort: Assess user comfort and ergonomics in the VR environment, considering factors such as motion sickness, eye strain, and fatigue. Make adjustments to the environment or interaction mechanics to improve user comfort.
- Accessibility: Ensure that the VR experience is accessible to users with different abilities and preferences. Test for accessibility features such as adjustable text size, color contrast, and alternative input methods.

4. Compatibility Testing:

- Hardware Compatibility: Test the VR experience on different VR hardware platforms, including Oculus Rift, HTC Vive, and PlayStation VR. Ensure compatibility with various VR headsets, controllers, and tracking systems.
- Software Compatibility: Verify compatibility with different software versions and configurations, including Blender, Unity, and VR runtime environments. Test on different operating systems and platforms to ensure broad compatibility.

5. Validation against Requirements:

- Requirements Traceability: Validate the VR computer lab environment against the project requirements and specifications. Ensure that all functional, visual, and usability requirements are met, and address any deviations or discrepancies.

6. Regression Testing:

- Stability: Perform regression testing to ensure that new updates or changes to the VR environment do not introduce regressions or break existing functionality. Test previously implemented features and interactions to verify their continued stability.

CHAPTER 6

RESULT AND DISCUSSION

6.1 RESULT

Fig no 6.1.1 Blender material preview

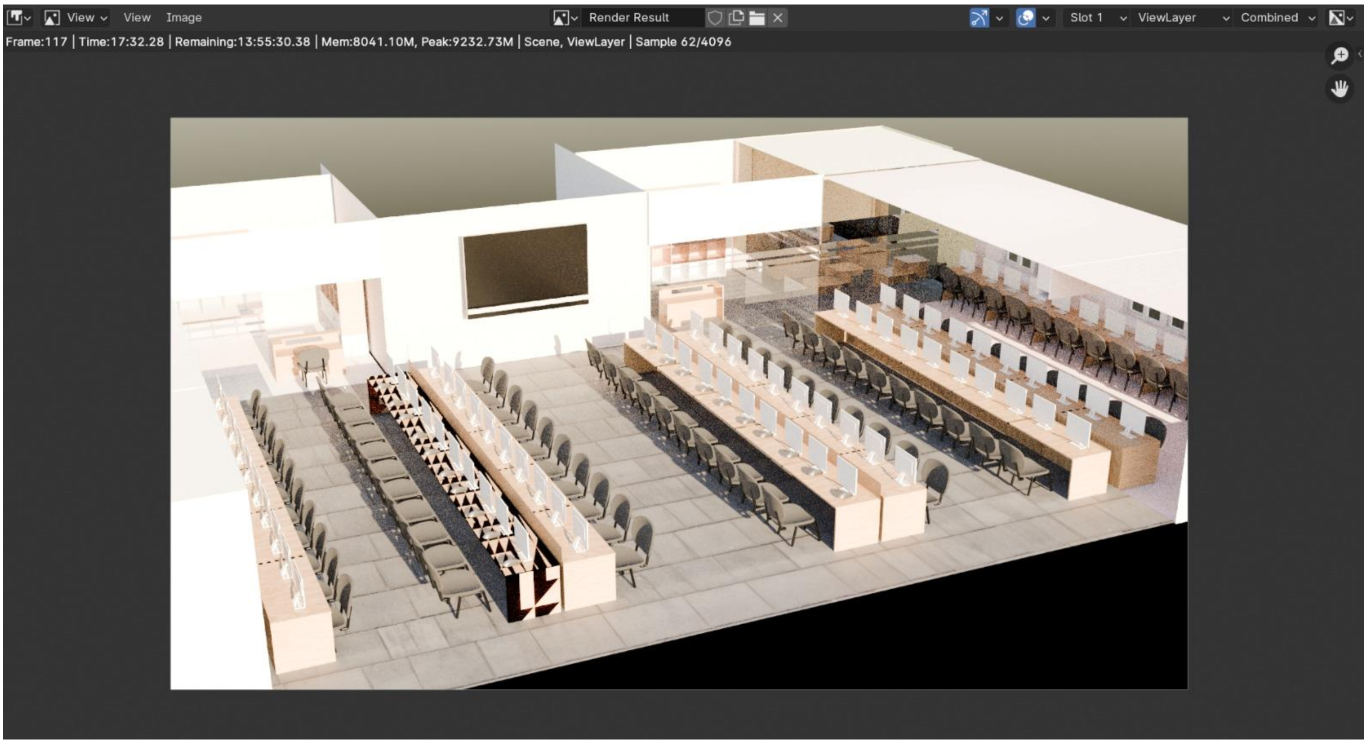

Fig no 6.1.2 Blender Rendered preview

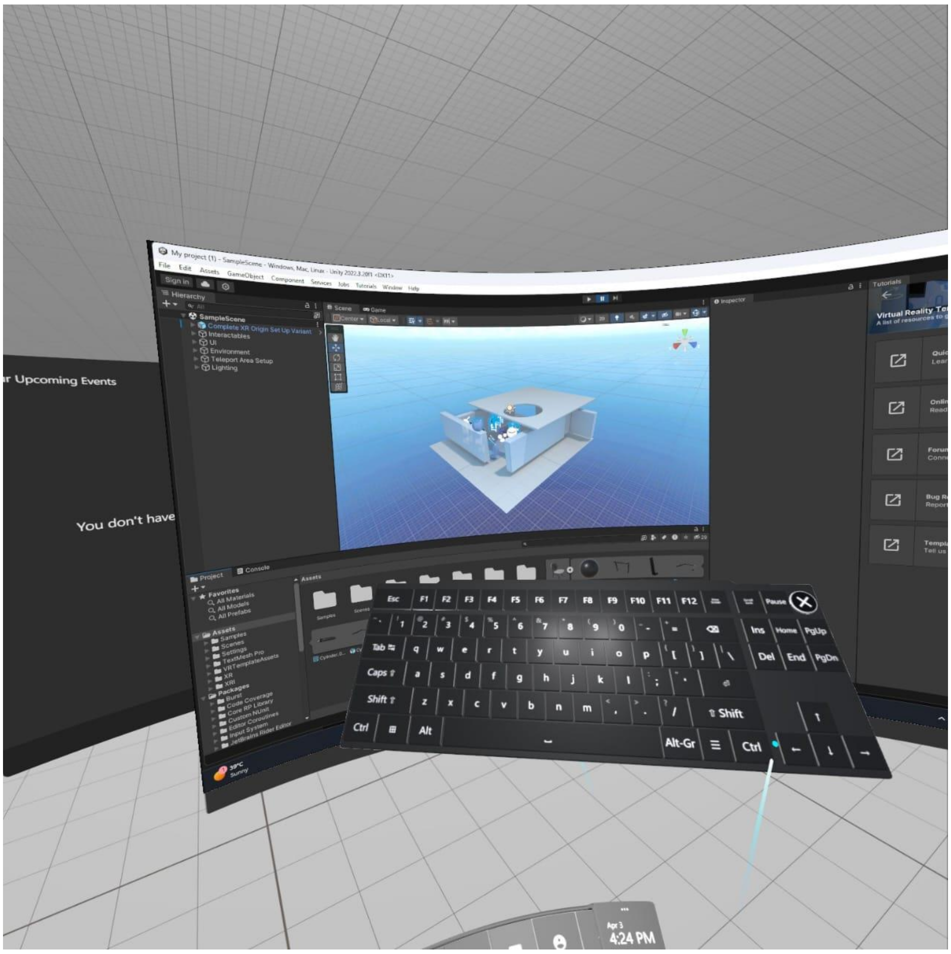

Fig no 6.1.3 Unity oculus view

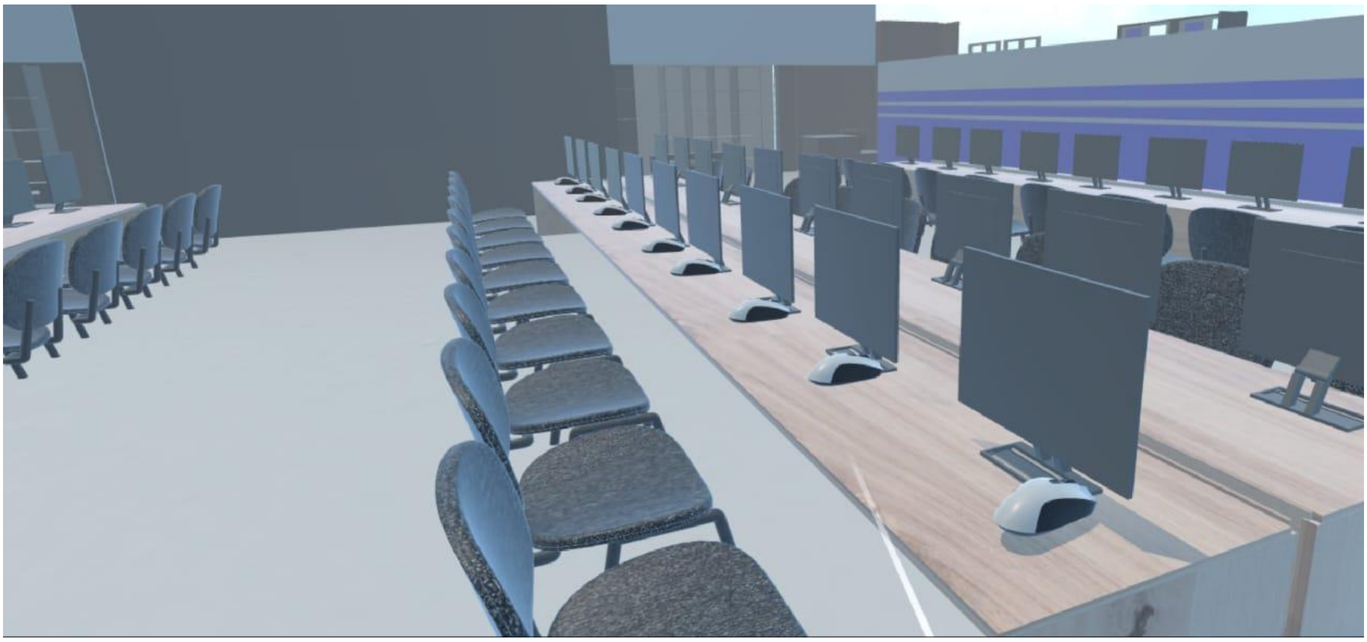

Fig no 6.1.4 Unity Textured View

CHAPTER 7

CONCLUSION AND FUTURE SCOPE

7.1 CONCLUSION

The development of a 3D model for a computer lab using Blender and its integration into a Unity project for VR offers a rich and immersive educational experience. Through the combined capabilities of Blender and Unity, along with the immersive nature of VR technology, users can explore and interact with a virtual computer lab environment in a realistic and engaging manner.

The development of a 3D model for a computer lab using Blender and Unity for VR opens up exciting possibilities for immersive education and training experiences. By leveraging the power of these tools and technologies, developers can create compelling virtual environments that facilitate learning, exploration, and engagement.

7.2 FUTURE SCOPE

1. **Enhanced Interactivity:** Future iterations of the VR computer lab could incorporate more advanced interactive elements, such as physics-based interactions, object manipulation, and collaborative features. This could enable users to perform tasks such as assembling computer components, conducting virtual experiments, or collaborating with other users in real-time.

2. **Real-time Simulation and Training:** The VR computer lab could be further developed into a platform for real-time simulation and training scenarios. This could include simulated troubleshooting exercises, virtual labs for computer hardware and software training, and interactive tutorials on computer programming and networking concepts.

3. **Customization and Personalization:** Users could be given the ability to customize and personalize their virtual computer lab environment, including choosing the layout, selecting equipment and peripherals, and customizing their workspace. This could enhance user engagement and satisfaction by providing a tailored experience that meets their specific needs and preferences.

4. **Expanded Educational Content:** The VR computer lab could be expanded to include a wider range of educational content and activities, such as virtual lectures, simulations, quizzes, and assessments. This could provide users with a comprehensive learning experience that combines theoretical knowledge with practical application in a virtual environment.

5. **Cross-platform Compatibility:** The VR computer lab could be optimized for cross-platform compatibility, allowing users to access the virtual environment from a variety of devices, including VR headsets, desktop computers, and mobile devices. This could increase accessibility and reach, enabling users to engage with the educational content anytime, anywhere.

6. **Research and Development:** Continued research and development efforts could explore innovative technologies and techniques for enhancing the VR computer lab experience. This could include advancements in graphics rendering, immersive audio, haptic feedback, and artificial intelligence to further enhance realism and immersion.

CHAPTER 8

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