FOSSEE Summer Fellowship 2025

On

Models, 3D Animation in Blender 4.4.0

Submitted by

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Under the guidance of

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Acknowledgement

I would like to express my gratitude to **Prof. Kannan M. Moudgalya** whose vision of FOSSEE has enabled me to work on such a noble and creative endeavour, imparting the gift of comprehension to those that need it. I would like to thank my mentor **Mr. Khushalsingh K. Rajput, (FOCAL Lead and Sr. Software Engineering. FOSSEE, IIT Bombay)**. If not for his quick-witted insight and mind-boggling creative suggestion, the animation would not have turned out to be as wonderful as they are now. He can understand the talent of students and give projects related to the student's talented topic. This may improve the quality of the project and gain a depth knowledge about the topics.

At last, I would like to take this opportunity to express my gratitude to the person who was instrumental for the conduction of this great programme. I show my greatest appreciation to **Prof. Kannan M. Moudgalya** for tremendous support throughout the fellowship.

I perceive this opportunity as a first milestone in my career development. I will strive to use gained skills and knowledge in the best possible way and I will continue to improve, in order attain desired career objectives. I also hope to continue cooperation with all of you in future.

With Regards,

Sagar Kumar

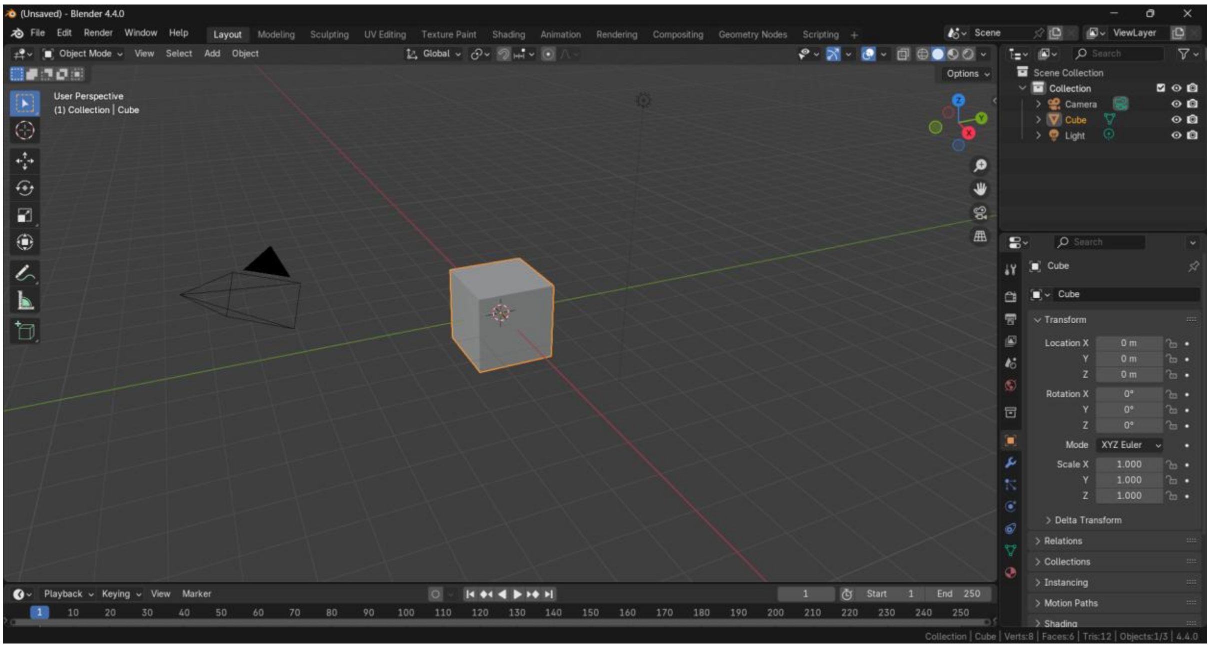
Contents

1 Introduction

1.1 About Blender

Blender is a free and open-source 3D computer graphics software that provides a complete pipeline for creating a wide range of digital content. It is widely used for producing animated films, visual effects, 3D printed models, video games, motion graphics, and interactive applications. The software includes powerful features such as 3D modelling, UV unwrapping, texturing, sculpting, rigging, animation, and rendering. In addition, Blender supports fluid, smoke, cloth, and particle simulations, as well as video editing, motion tracking, and compositing.

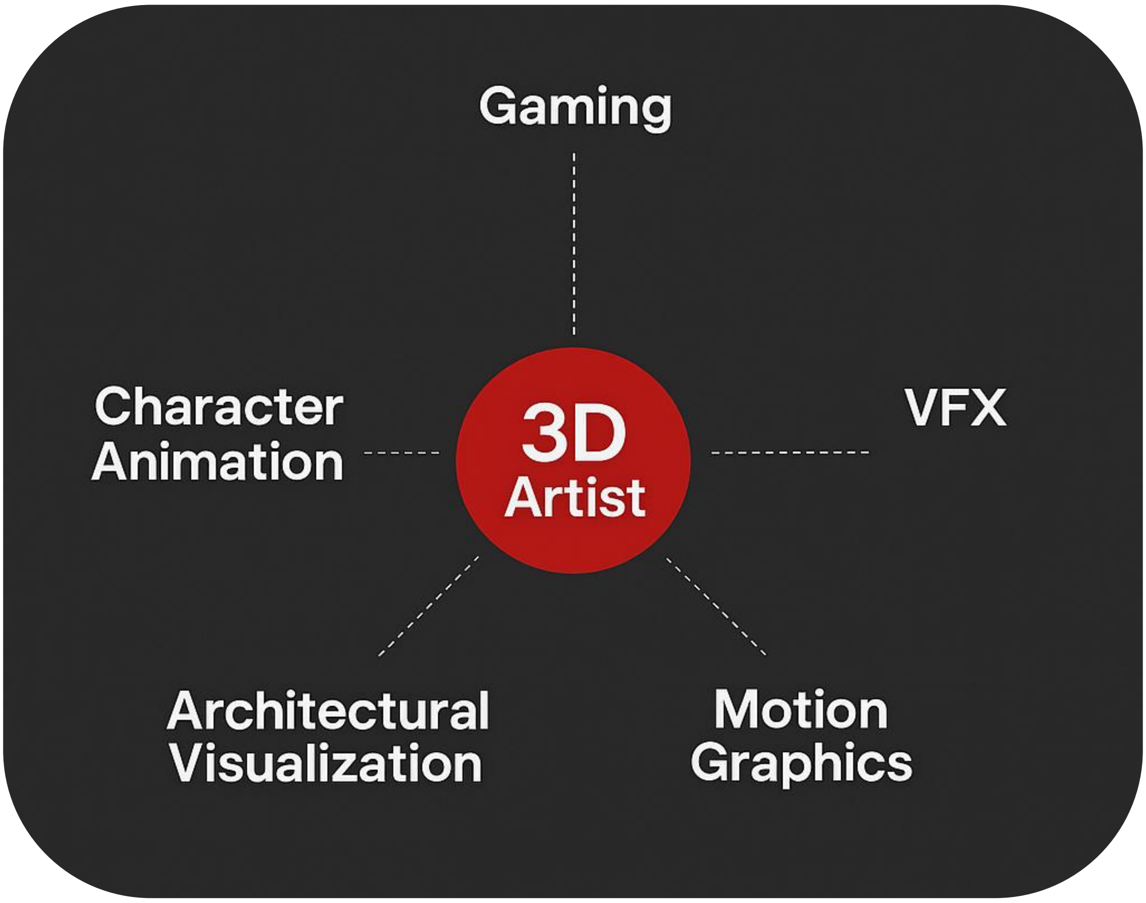
The projects ware created using Blender 4.4.0, taking advantage of both the Cycles and Eevee rendering engines depending on scene complexity and rendering needs. Cycles were used where high-quality ray tracing was necessary, while Eevee allowed for fast previews and real-time rendering. Both engines provided flexibility and efficiency during different phases of the project.



1.2 Skills Required to Be a 3D Artist

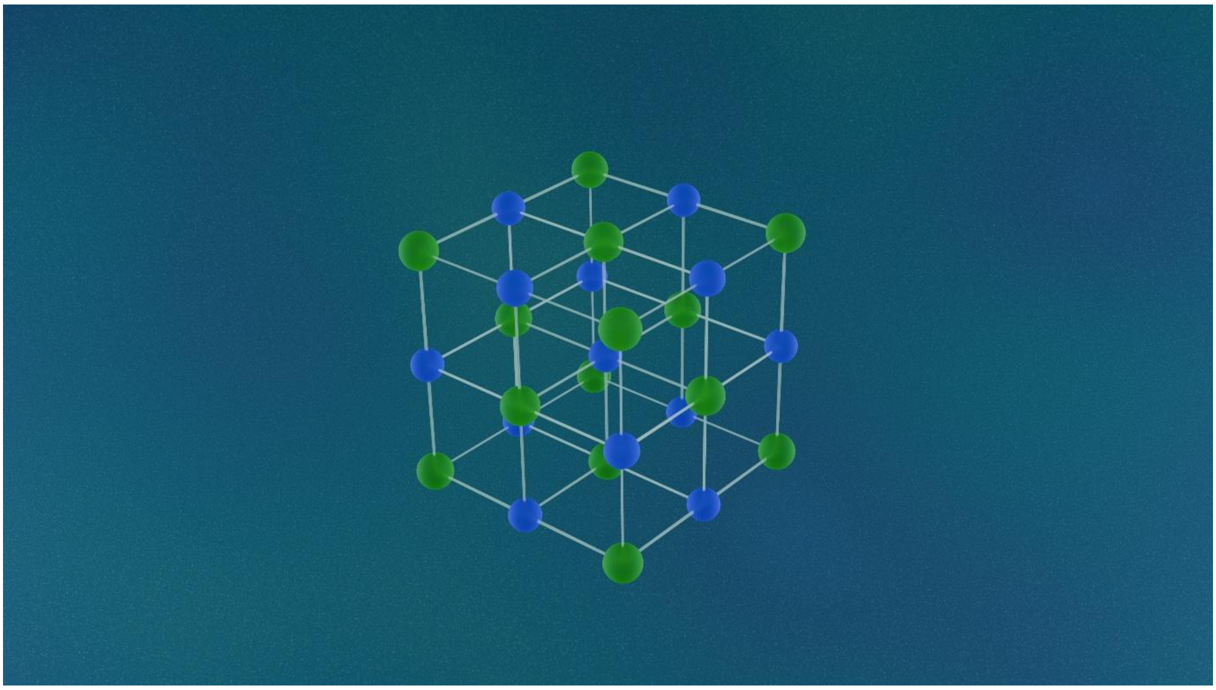
A 3D artist using Blender needs both creative and technical skills. Key tasks include modelling, texturing, shading, lighting, and rendering to create detailed and visually appealing assets. Sculpting, rigging, and animation are also essential for bringing characters and scenes to life.

Modern Blender artists often work with simulations like cloth and fluids, and procedural tools like Geometry Nodes. Skills in compositing, video editing, and camera movement further enhance storytelling. These abilities make them valuable in industries such as film, games, architecture, motion graphics, and visual effects.

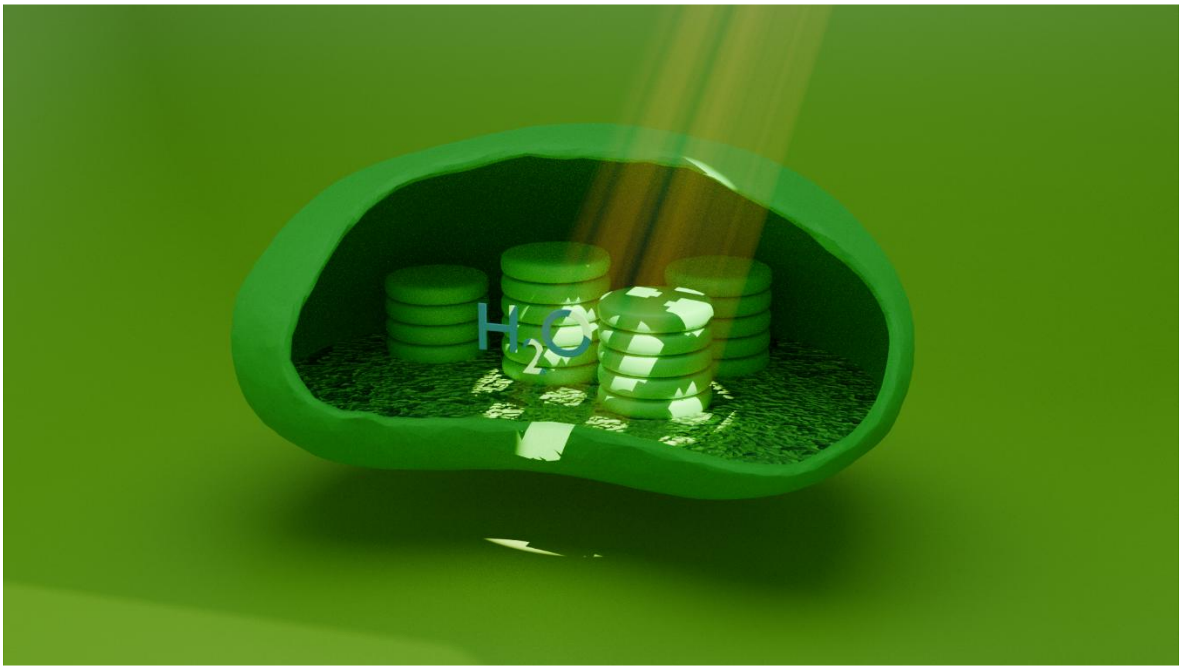


1.3 About 3D Models and Animation

3D models are digital representations of objects created using geometric data like vertices, edges, and faces. They are used in various fields such as gaming, virtual reality, films, 3D printing, and architecture. In the projects, I created different models that help visualize realistic spaces and can be reused in future projects.



Animation is the process of bringing 3D models to life by adding motion. It includes techniques like keyframing, rigging, and timeline-based editing. Using Blender, I animated different objects and scenes to simulate real-world actions and movements, making the visuals more dynamic and engaging.



2. Work Flow

2.1 Studying About Topics

First step to making a video is to read and study about the topic on which you will be making a tutorial. So that you don't pass any wrong or incorrect information to the viewers.

I used Wikipedia, YouTube, Instagram for inspiration, NCERT Books to collect information about the topics and get the idea of what I want to show to viewers to help them understand the concepts.

2.2 Warm Up Tasks

2.2.1 Looping Animation Task

Description: Created a seamless, infinitely looping animation of cubes gradually transforming and falling into a void.

Key Techniques: -

- Crafted variations of cube mesh using displace and bevel modifiers.
- Implemented an infinite loop camera rig with cyclic keyframes.
- Experimented with procedural textures for surface variety.

Outcome: Demonstrated control over timing curves and material parameters to produce a polished loop animation.

Animation Link - https://drive.google.com/file/d/1Yv4bvXcIullaOHbIabF35VQTZTpEbw1C/view

2.2.2 JRS Portal Login Animation

Description: Animated a short sequence of a user interacting with a computer login interface.

Key Techniques: -

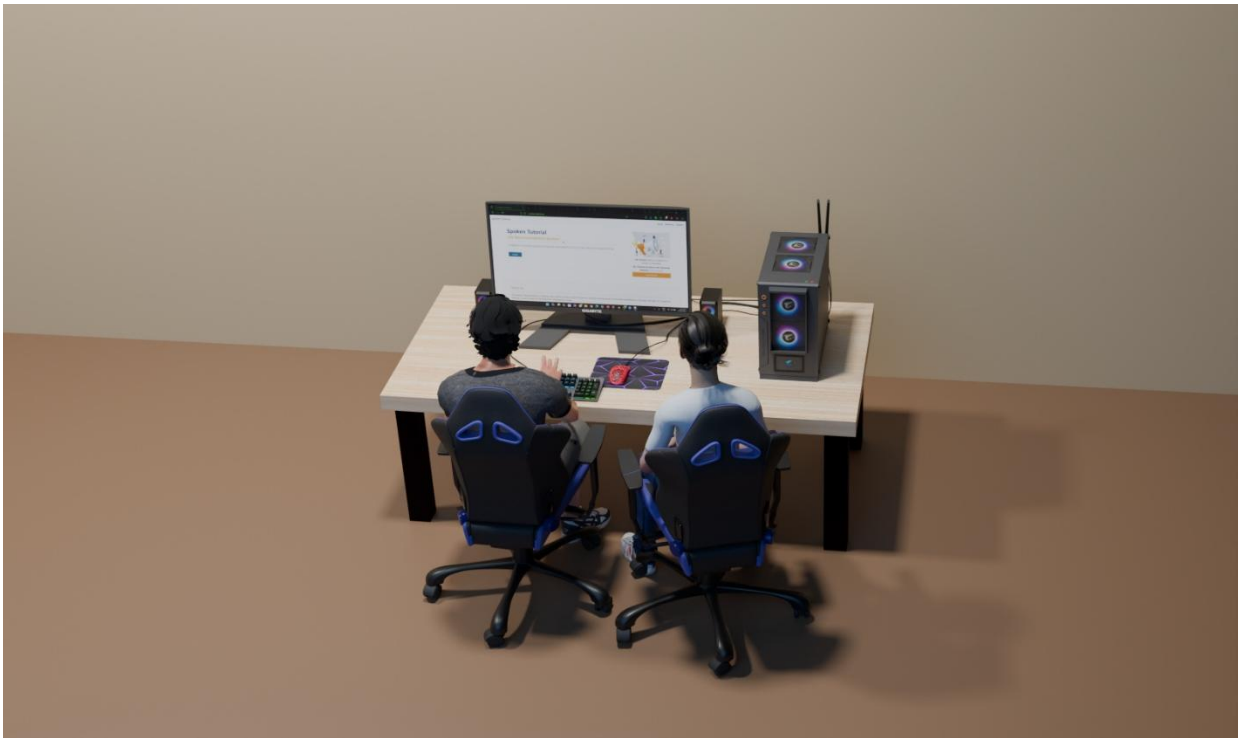
• Modelled a desktop workstation environment with modular assets.

• Simulated character interaction using simple armature rigs and constraints.

• Applied screen-space UI overlays to mimic real-time portal behaviour.

Outcome: Highlighted the integration of 2D UI elements within a 3D scene to enhance user experience.

Animation Link - https://drive.google.com/file/d/1WwECNS0zpPe24gwfSWYxlRI-xDH4yp6B/view



2.3 Main Tasks

2.3.1 Photosynthesis Animation

Description: A step-by-step portrayal of photosynthesis within a leaf cross-section.

Key Techniques: -

- Modelled internal leaf structures, including thylakoid and chloroplasts.
- Used text models to represent gases and liquids (CO_2, O_2, H_2O).
- Applied volumetric lighting to illustrate energy transfer from sunlight.

Outcome: Simplified a complex biochemical process into an educational animation suitable for classroom presentations.

Animation Link - https://drive.google.com/file/d/1b_l1IrmV9cvW7k59xvsjMCOPmyC4BwFd/view

2.3.2 Chemical Bonding: Ionic Bond

Description: Animation illustrating the transfer of an electron from a sodium atom to a chlorine atom, representing the formation of an ionic bond.

Key Techniques: -

• Visualized electron as spheres around the nucleus in orbits.

• Animated electron transfer and crystal formation in Sodium Chloride.

• Incorporated glow and emission shaders for visual emphasis.

Outcome: Clarified fundamental chemistry concepts through contrasting visual metaphors.

Animation Link -
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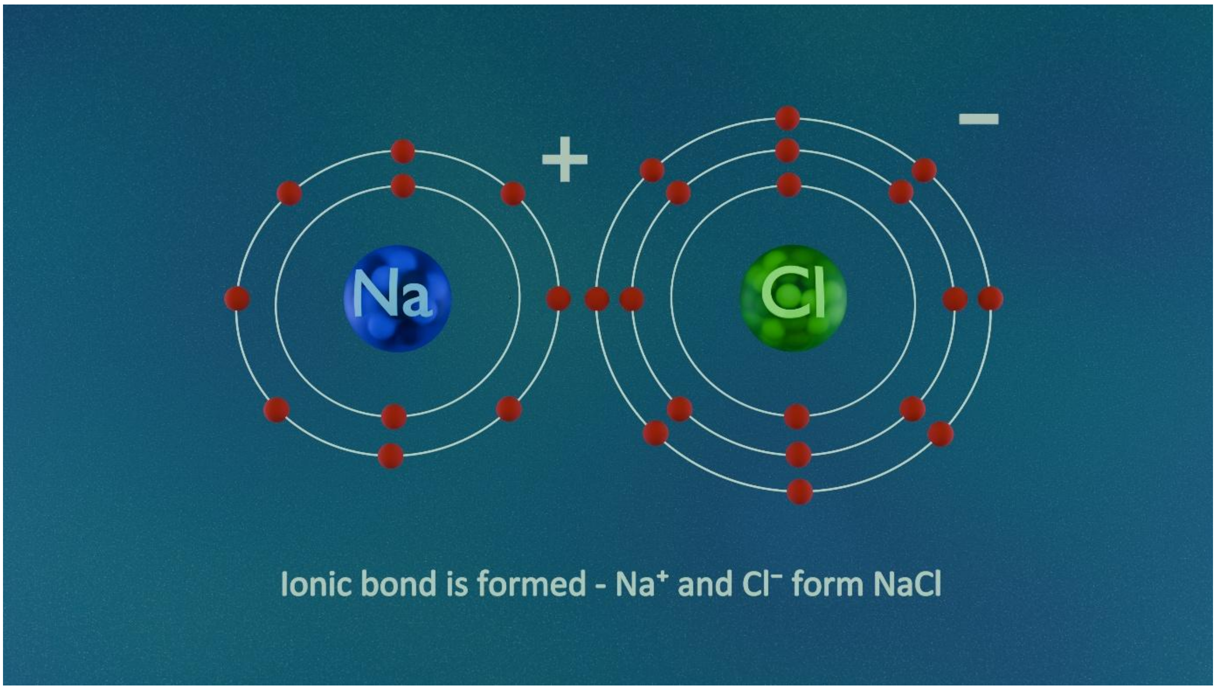


2.3.3 Chemical Bonding: Covalent Bond

Description: A 3D animation showcasing the process of electron sharing between non-metal atoms, where overlapping orbitals lead to the formation of stable covalent bonds, as seen in molecules like H_2 and H_2O.

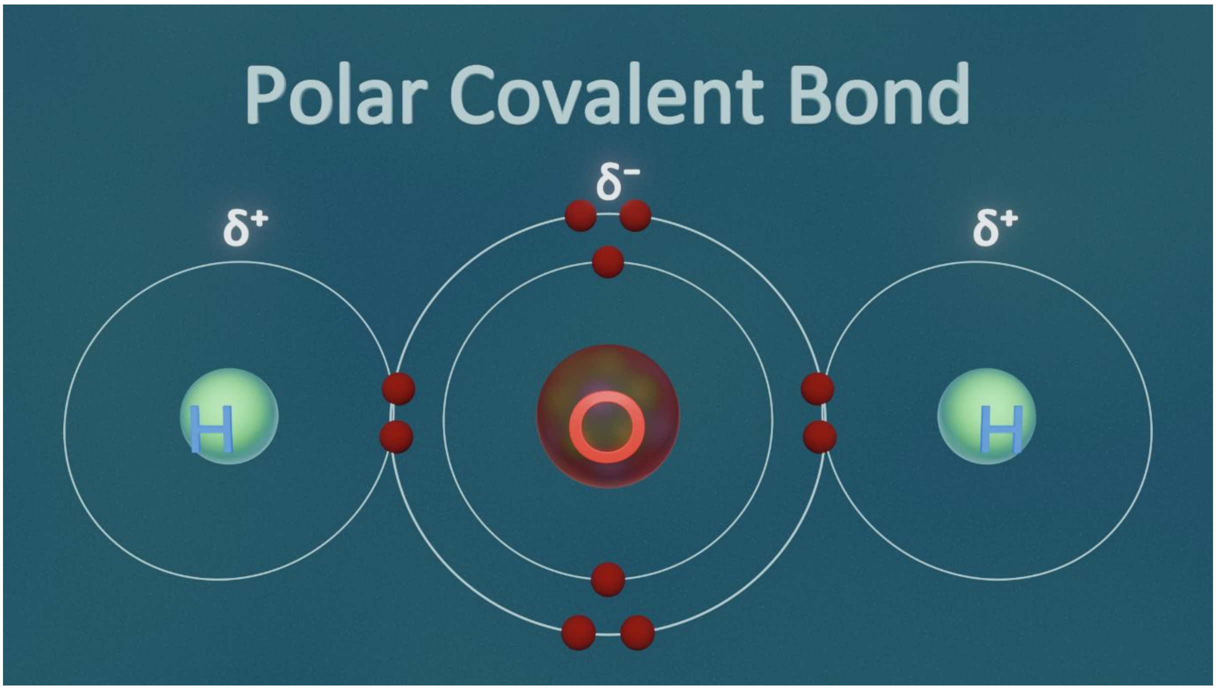
Key Techniques: -

- Visualized electron as spheres around the nucleus in orbits.
- Animated orbits overlapping and electron sharing.
- Incorporated glow and emission shaders for visual emphasis.
- Also differentiated between polar and non-polar covalent bond.

Outcome: Effectively illustrated core chemistry concepts by using contrasting visual representations of bonding types.

Animation Link –

https://drive.google.com/file/d/1a1iWjC1uia1x1MuMPSqyby3bA-YYhw3s/view



2.3.4 3D Proof of the Pythagorean Theorem

Description: Visual proof demonstrating that in any right-angled triangle, the square of the hypotenuse equals to the sum of the squares of the other two sides.

Key Techniques: -

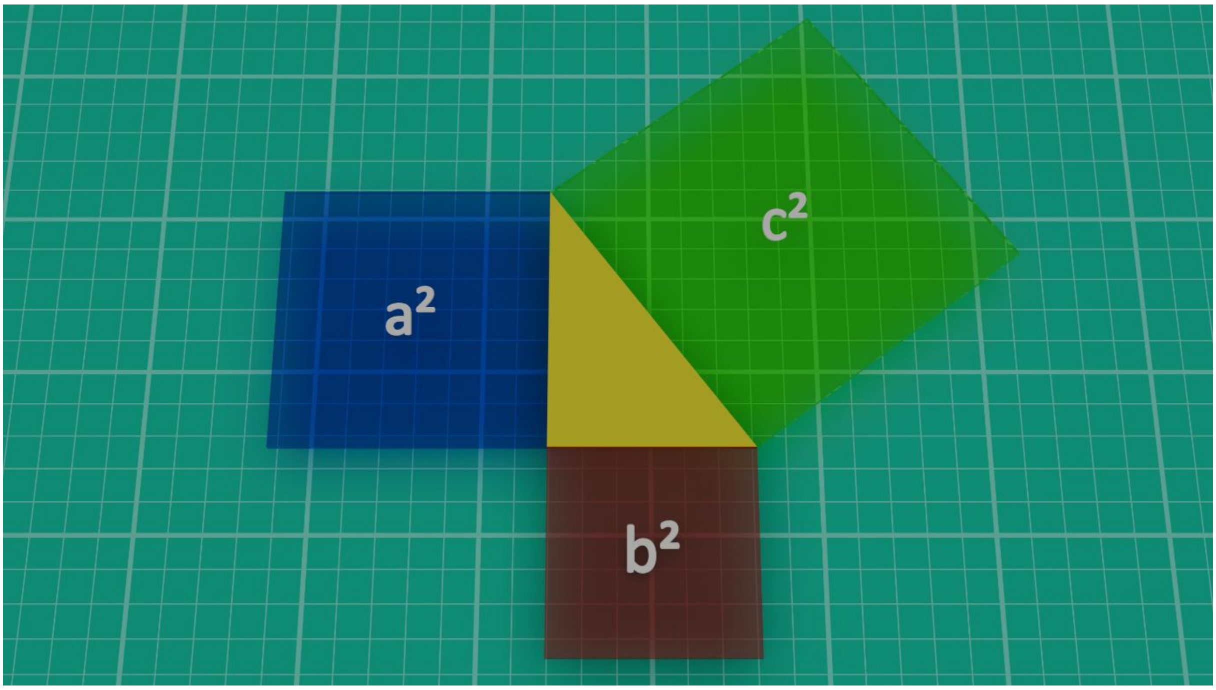
• Built geometric primitives for the triangle and three squares and added animation for their appearance.

• Used loop cuts and separate selected to create the small pieces.

• Animated piece rearrangement to form matching areas.

Outcome: Provided an intuitive, visual proof that reinforced mathematical reasoning through animation.

Animation Link - https://drive.google.com/file/d/1s8pFrW3GAGz9esdE0yoS-drP0k-nx4OQ/view



2.4 Animate Intro Video Tasks

2.4.1 Scene 1

Description: Animated scene 1 for *ANIMATE 2025*. The scene welcomes viewers with dynamic motion graphics and logo animation.

Key Techniques: -

• Designed and animated the *ANIMATE 2025* logo using keyframes and modifiers.

• Applied vibrant colour transitions to enhance visual appeal.

• Added animated text appearance animation to introduce the event and create a professional opening sequence.

Outcome: Created an engaging, high-energy intro that effectively sets the tone for the hackathon and captures audience attention.

Animation Link - https://drive.google.com/file/d/1BqNmjsI2dHtBqAP4RhCTmwK4Mg3d2LQu/view

2.4.2 Scene 8

Description: A short-animated scene highlighting that registration for *ANIMATE 2025* is completely free. A stamp-style badge pops onto the screen to convey the message clearly and energetically.

Key Techniques: -

• Designed a starburst "Free Registration" badge using shape tools and custom text.

• Applied glow and emission animation to create focus on free registration.

• Used motion blur and colour contrast to make the badge stand out against the background.

Outcome: Delivered a clear, visually appealing message about free registration that enhances viewer engagement and encourages participation.

Animation Link - https://drive.google.com/file/d/1qj5bxxqeeHmW8fnDPT1vs481am3FN93c/view

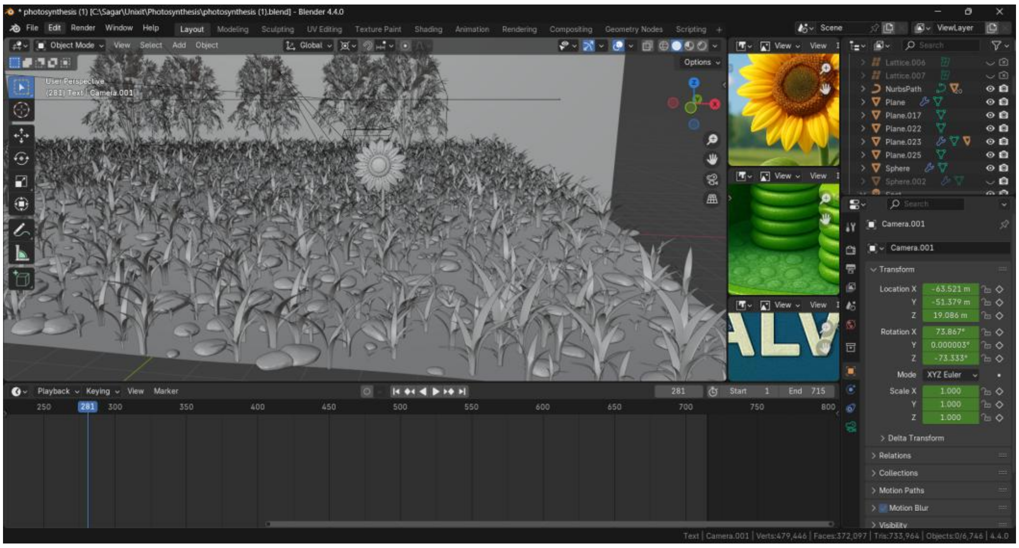
2.5 Animation and Creating Models

Animations are a sequence of images shown in rapid succession to create the illusion of continuous motion. In 3D graphics, animation brings static models to life through movement, timing, and transitions.

2.5.1 Modelling

Modelling is a fundamental process in computer graphics used to create 3D digital representations of objects or surfaces. Artists use specialized software to manipulate points in virtual space—called vertices—to build a mesh, which is a collection of interconnected vertices forming the shape of an object. These vertices are positioned within a 3D grid and connected to form polygonal shapes, usually triangles or quads. When combined, they define the surface and volume of the object.

Modelling often involves customizing polygon shapes with the help of modifiers like Solidify, Wave, Mirror, and Subdivision Surface. Empty objects may be used in conjunction with these modifiers to define motion along specific axes.



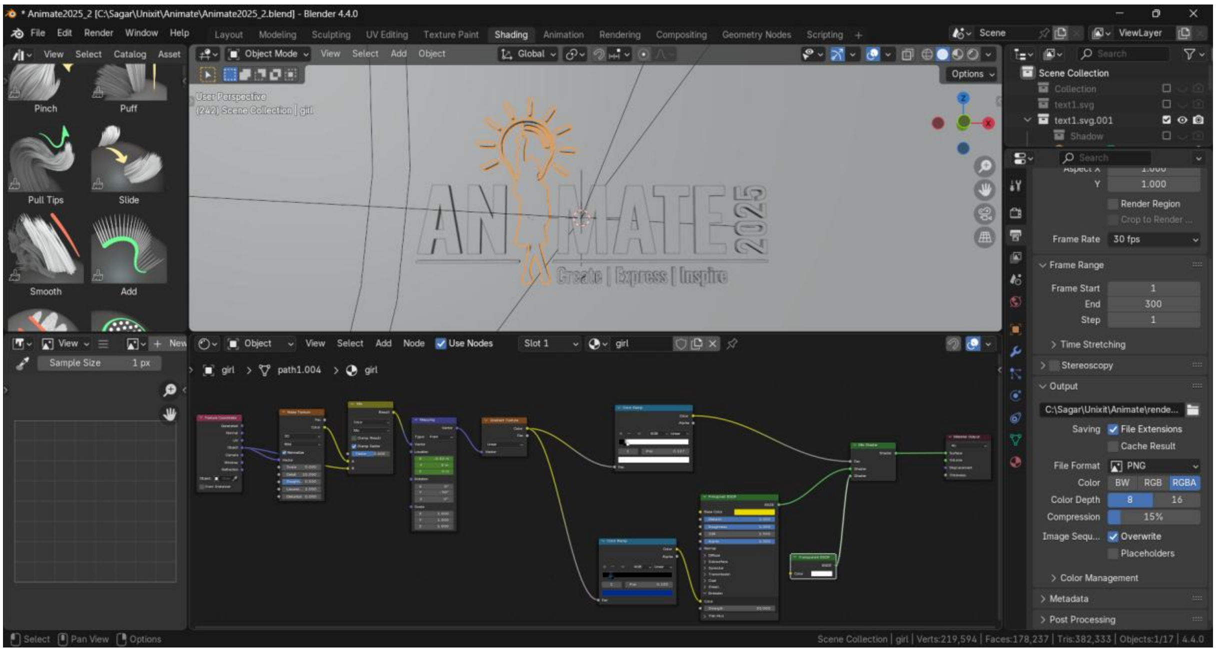
In many cases, reference images are used to guide polygon customization. Depending on the object, both hard surface modelling (for rigid, mechanical parts) and soft surface modelling (for organic, flexible shapes) are employed.

2.5.2 Texturing and Procedural Nodes

After the 3D model is complete, materials are applied to give it realistic appearance. This is a crucial step in achieving photorealism. In Blender, both Cycles and Eevee render engines are utilized, with extensive use of material nodes to define colour, reflectivity, roughness, and other surface properties.

In one part of the project, abstract environments and stylized elements were created using Blender's Geometry Nodes and modifiers, instead of traditional polygon modelling. Procedural setups were used to generate waveforms, terrain-like patterns, and particle-based effects, which were looped for visual interest.

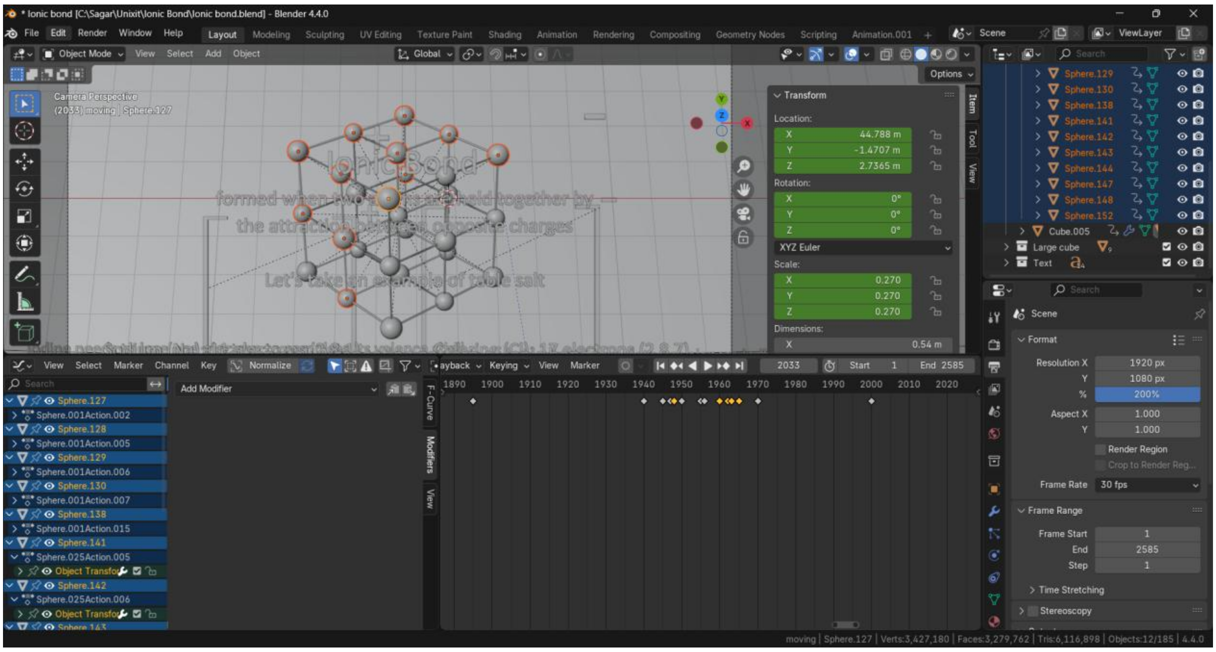
Instead of realistic texture maps, procedural shaders with noise, gradients, and emission nodes were applied to achieve a vibrant, stylized look. These assets were integrated into animated loops with basic HDRI lighting setups to give depth and contrast to the scenes.



2.5.3 Animation

Animation involves moving objects or armatures (skeletal bones) across frames and adding keyframes to define their position at specific points in time. Tools like Graph Editor and Dope Sheet are used to fine-tune the speed and flow of animations.

Keyframes can be inserted through node editors and animation tabs in Blender. The Dope Sheet allows precise control over timing and movement paths. For instance, if an object is set to move along a circular path, the Graph Editor helps adjust its speed smoothly over time—something that isn't directly possible through simple keyframing.



2.5.4 Testing

Testing is the final check to ensure that the animation behaves as expected. It helps catch issues such as incorrect frame timing or material inconsistencies. Before presenting the animation or integrating it into a larger project, testing ensures that the visual experience—especially in VR or cinematic formats—delivers the intended effect to the viewer.

2.5.5 Rendering

Rendering is the process of generating a 2D or 3D image or animation from a scene using rendering engines. It is used extensively in architectural visualization, video games, movies, simulators, and special effects.

This step is typically the most time-consuming, as each frame must be rendered as an individual image, which are then compiled into a video sequence at a chosen frame rate (FPS).

Large-scale projects may not render efficiently on systems with limited GPU power. In such cases, Blender Render Farms—community-supported rendering services—can be used to significantly reduce render time and offload processing.

3. Issues Faced and Solutions

• **Loop Continuity Challenges**: Early loop tests showed visible seams.

Solution: Refined keyframe interpolation and used graph editor to ensure first and last frames aligned perfectly.

• **Character-Environment Interaction**: Difficulties syncing hand movements to UI elements.

Solution: Applied constraint targets and adjusted animation curves for precise timing.

• **Render Performance**: High sample settings caused long render times.

Solution: Adopted adaptive sampling, optimized material nodes, and denoising techniques.

• **Scientific Accuracy**: Translating biochemical pathways into visuals was complex.

Solution: Consulted academic references and adjusted models/animations to match real-world scales and reactions.

4. References

To Study

- Wikipedia - Concept Study
- YouTube - Concept Study
- Blender 4.4.0 Documentation

Links For Project Document: -

Looping Animation -
https://docs.google.com/document/d/1I1Orb_RrYqpSCXsmWW3-Q1Nb-Zcx-1uiSej3aT9XOks/view

JRS Portal Login Animation -
https://docs.google.com/document/d/1AJIiWgOJe-GvzSYtuyhpi41jyPOy9wXpixRsQjjeijE/view

Photosynthesis Animation - https://docs.google.com/document/d/1zf-PNQfcGrQD0Mp0kuCRVhNarEIeyxqoK5xNSWBvaU0/view

Ionic Bond - https://docs.google.com/document/d/1ygnzJENJsy-MzxndRps3ZCCCwcR5oXVsfr5wTQ6wtbk/view

Covalent Bond -
https://docs.google.com/document/d/1hk1uxP2BS3Z2zOLBwt6G3mvuVVMcxGZL4HteXENsuqY/view

Pythagorean Theorem -
https://docs.google.com/document/d/1vUn42Xp5T7scYlIwnxcVmUOAoJ7ufILI7TNjROdCksc/view