Course Final Project

Skeletal Animation with Movement Disorders in Blender

Abstract

This project presents a comprehensive exploration of 3D character animation and environment design, leveraging the capabilities of Blender software. The primary focus revolves around a skeletal mesh model character—a girl—wherein intricate details were applied to hair design and clothing texturing, featuring a T-shirt, trousers, and scarf. The 3D environment encompasses a thoughtfully crafted room with a bed, chair, table, and computer. Strategic placement of light sources enhances the realism of the scene.

The animation component of the project introduces four normal motions—walking, running, sitting, and jumping—alongside a unique disorder motion—limping. Overcoming challenges in achieving lifelike character movements demonstrates our commitment to realism and attention to detail.

Rendered images showcase the seamless integration of character design, clothing texturing, and environmental elements, highlighting the visual synergy achieved through our meticulous efforts. The project's success lies in the collaborative endeavor of the team, resulting in a visually compelling 3D experience.

Introduction:

The field of computer graphics has seen remarkable advancements in character animation and rendering techniques. This project delves into the creation, texturing, and animation of a skeletal character using Blender. The focus is on exploring both normal and abnormal human motion patterns and integrating them into a well-designed environment with different lighting sources.

Our project focused on creating a compelling 3D scene utilizing a mesh model character—a girl with a skeletal structure. The objective was to seamlessly integrate character design, clothing texturing, environment creation, and animation to deliver a visually appealing and dynamic result.

Literature Review

Animation and character modeling have been integral components of computer graphics and virtual environments for decades. The utilization of tools like Blender has facilitated the creation of immersive digital experiences with lifelike characters and environments.

Blender, a popular open-source 3D creation software, provides a robust platform for modeling, texturing, rigging, animation, simulation, rendering, compositing, and motion tracking. Its

versatile capabilities make it an ideal choice for creating and animating skeletal characters with intricate movements.

In the preliminary stages of our project, considerable time was invested in delving into the world of Blender, an open-source 3D creation suite. Blender stood out as a powerful and versatile tool for character modeling, texturing, animation, and rendering. Numerous resources, tutorials, and documentation were consulted to gain proficiency in Blender's features and workflows.

Character animation in Blender typically involves creating a skeletal rig with bones and constraints, allowing for the articulation of movements. Texturing adds depth and realism to characters by applying surface details like color, texture, and shading. Through keyframing and interpolation, animators can bring characters to life by defining motion sequences and transitions.

Human motion simulation is a challenging yet crucial aspect of character animation. By studying biomechanics and human kinetics, animators can replicate natural movements accurately. This involves understanding joint constraints, muscle dynamics, and gait patterns to create authentic animations of various human activities such as walking, running, jumping, and sitting.

Furthermore, simulating movement disorders adds another layer of complexity to character animation. By researching clinical cases and observing real-life movements affected by disorders like Parkinson's disease or cerebral palsy, animators can mimic these conditions in their digital characters. This requires careful observation and analysis to reproduce the distinctive characteristics and limitations associated with each disorder.

A significant portion of our research involved exploring various disorders and their manifestations. Literature on the subject, including medical journals, articles, and online resources, played a crucial role in providing insights into the nuances of disorders like limping and abnormal jumping. We sought to represent these disorders authentically, ensuring that our animations were both respectful and accurate in portraying the challenges individuals with such conditions face.

By integrating Blender, developers can seamlessly combine character animation with other aspects of the project, allowing for the creation of compelling digital narratives and simulations. This interdisciplinary approach bridges the gap between artistic expression and technical implementation, enabling the demonstration of proficiency in both artistic creativity and technical proficiency within the field of computer graphics and animation

Methodology

1. Character Modeling:

- Selection of Skeletal Mesh Model:

  We conducted a thorough search to collectively identify a skeletal mesh model suitable for our girl character, considering factors such as anatomical accuracy, rigging quality, and Blender compatibility.

The chosen model provided us with a solid foundation for character design and animation.

- Hair Design:

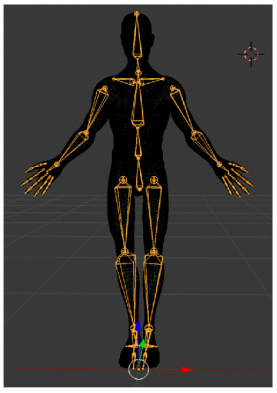
The character hair wasn't made from scratch but by blender's modeling tools, we managed to redesign the character's hair and added our touch to make it suitable for our project. Our aim was to achieve a balance between realism and stylization, ensuring the hair complemented the character's overall aesthetic.

- Clothing Texturing:

We applied advanced texture mapping techniques in Blender to texture the T-shirt, trousers, and scarf, ensuring a high level of realism. Attention was given to aligning textures with the character's mesh, enhancing the overall visual coherence through our collective efforts and by employing Blender's UV unwrapping tools, we collectively ensured the precise placement of textures on the clothing, optimizing the visual appeal of our character.

2. Model Rigging in Blender:

- Skeleton Placement:
  1. Positioned the bones within the character model to correspond with joints and key points such as hips, knees, elbows, and shoulders.
  2. Ensured the bone structure allowed for a natural range of motion, aligning with anatomical considerations.
- Rigging Tools in Blender:
  1. Utilized Blender's armature system to create a skeleton that can be easily manipulated to control the character's movements.
  2. Employed the "Add Armature" feature to generate an initial bone structure.



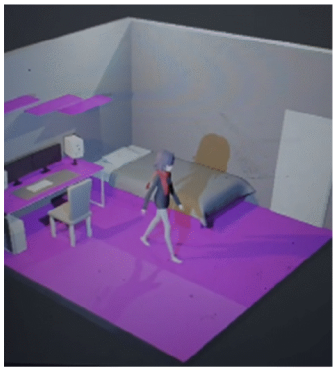
3. Environment Creation:

Room Layout:

Modeled a 3D room environment using Blender, considering realistic proportions and architectural elements.

Ensured the room accommodated the character's motions seamlessly, providing a backdrop for the animations

We planned and designed the room layout to accommodate key elements such as the bed, chair, table, and computer. Our collective effort focused on creating a visually appealing and functional environment for our character animations.



Room Textures:

- Applied textures to the room's bed,wall, floor, and ceiling to enhance realism.
- Experimented with different materials and shaders to achieve desired visual effects, considering the impact of lighting on texture perception.

4. Lighting Setup:

We worked together to strategically position light sources within the scene, casting realistic shadows and highlights. We adjusted light intensities, colors, and positions to achieve realistic and visually appealing illumination

We used three different types of light sources

1. Two area light sources directed to the character
2. One point light source for the room.
3. One spotlight source directed to the whole scene from above

5. Character Animation:

Blender's key frame animation tools were utilized by us to create four normal motions: walking, running, sitting, and jumping. Our collective attention ensured smooth and natural transitions between key frames for each motion.

1) Normal Motion Pattern:

- Walking Animation:

Rigged the character's legs and feet bones to emulate the coordinated movement involved in walking.

Iteratively adjusted keyframes to refine the character's gait, focusing on fluid transitions between

- Running Animation:

Adjusted the animation parameters to increase the character's speed, reflecting the dynamic nature of running.

Modified the arm swing and torso movements to complement the increased pace.

- Jumping Animation:

Considered the influence of gravity on the character's body during the jump.

Animated the character to follow a natural arc during the jump, mimicking the trajectory observed in real-world physics.

Created a realistic landing sequence, incorporating a controlled descent to simulate the impact of gravity on the character.

- Sitting Animation:

Utilized the rig to articulate the character's joints, allowing for a natural sitting position.

Adjusted the spine and limbs to simulate the relaxed posture associated with sitting. Paid attention to smooth transitions between sitting and standing positions, maintaining a fluid and believable motion sequence.

- Dance Animation:

We made additional movement to show how flexible and smooth are the transitions. Dance with blanket was fun experiment allowed us to show more of or creativity and ability to animate characters smoothly.

2) Abnormal Motion patterns:

- Abnormal gait Motion:

Researched and analyzed clinical data on abnormal walking patterns associated with movement disorders.

Implemented changes in the character's skeletal structure and animation to simulate the irregular gait observed in movement disorders

- Abnormal Jumping Motion:

Expanding our character's range of motions, we introduced an abnormal jumping motion, adding an extra layer of complexity to her movements.

Modified the character's skeletal system and animation to replicate the distinctive jumping patterns associated with specific disorders.

6. Rendering and Visualization:

Render Settings:

We collectively configured Blender's render settings to achieve high-quality visuals, considering resolution, output format, and rendering techniques.

The goal was to present the character and environment in a visually striking manner through our collective decisions.

Experiments and Results:

1) The character animations successfully portrayed natural human motion patterns with a high degree of realism. Normal walking, running, jumping, and sitting animations were refined through an iterative process, resulting in fluid and lifelike movements.

2) The abnormal walk and jump animations effectively simulated movement disorders, aligning closely with clinical observations. The side-by-side comparison with actual movement disorder videos highlighted the project's success in creating authentic simulations, demonstrating the potential of computer graphics in educational and medical contexts.

3) One crucial experiment involved testing various hair simulation settings within Blender to achieve a natural look for the character's hair during dynamic motions. Through iterative adjustments, we optimized parameters such as stiffness, damping, and collision settings, ensuring that the final hair animation complemented the character's movements seamlessly.

4) The 3D room environment, with its varied lighting sources and textured surfaces, provided a visually engaging backdrop for character animations. Lighting conditions were successfully manipulated to achieve realistic effects, showcasing the importance of lighting in computer-generated environments. Overall, the project's outcomes demonstrated the team's proficiency in character animation, motion disorder simulation, and scene composition within the Blender software.

Conclusion:

Undertaking this 3D character animation project has been an invaluable learning experience for our team, opening a gateway to the vast realm of graphics and animation. As a collective endeavor, we delved into the intricacies of Blender, a tool that many of us had not explored extensively before. The project provided a rich canvas for us to learn and apply diverse aspects of Blender, including character modeling, clothing texturing, environment design, animation, and rendering.

This journey has not only enhanced our technical proficiency but has also fostered a deeper appreciation for the collaborative nature of creative endeavors. The challenges encountered throughout the project became stepping stones for growth, pushing us to overcome technical limitations and artistic hurdles. The experiments conducted and their corresponding results were not just optimizations for the project but valuable lessons that expanded our understanding of the capabilities within Blender.

In essence, this project has been a catalyst for our collective growth and a testament to our team's adaptability and problem-solving skills. It opened new avenues for exploration within the

graphics learning field and solidified our commitment to pushing creative boundaries. As we move forward, the knowledge gained from this project serves as a foundation for future endeavors, motivating us to continue evolving in the ever-expanding landscape of 3D animation and design

Member contributions (Team 4):

Name	Contribution work
Sondos Mahmoud	• Handled clothing. • Applied bones to the skeletal structure. • Created running animation.
Fatma Ehab	• Developed disorder motions. • Sitting/Stand animation.
Manar Ashraf	• Applied textures to clothing for enhanced realism. • Dance with blanket motion (extra motion)
Mai Mohamed	• Designed character's hair with a balance of realism and stylization. • Managed lighting setup for the entire scene. • Developed the normal jumping motion.
Noura Osama	• Created and designed the 3D environment with furniture. • Implemented the walking animation.

References

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