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Animation and VFX : Comprehensive Review of Processes and Software.

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Abstract - *Animation and visual effects (VFX) are two of the most important aspects of modern filmmaking. Animation is the process of creating the illusion of motion using a series of still images in rapid succession. VFX is the process of creating or altering images using digital effects. In recent years, there has been a significant convergence between animation and VFX due to the increasing use of computer-generated imagery (CGI) in both industries. CGI allows for the creation of realistic and immersive worlds and characters that would not be possible using traditional animation techniques. This review paper will examine the latest trends and developments in animation and VFX, as well as the processes involved and methods employed in these industries.*

Key Words: Animation, VFX, CGI, 3D, visual effects.

1.INTRODUCTION

The history of animation and VFX traces back to the 1880s and 1850s, respectively. Early animation techniques included stop- motion with objects, puppets, clay or cutouts and hand painted animations. With the invention of the "Théâtre Optique" by Charles-Émile Reynaud, a French inventor, Pauvre Pierrot became the first projected animated film out of three made for the technology's original 1892 showing. It was not until 1908 that the first animated cartoon came out, which was Émile Cohl's Fantasmagorie. However, it was established as the first recorded instance of a projected, hand-drawn animated film. Later developments led to small animators owning their animation studios, some of which revolutionized the industry. The drawing of animation directly onto celluloid sheets was invented by Earl Hurd, a Bray Studios animator, which he patented. This practice came to be known as cel animation and was the industry standard until the rise of digital animation techniques [1].

VFX stands for visual effects. The history of visual effects began in 1857 when Oscar Rejlander, a Swedish-born photographer, created the world's first "special effect" image by combining sections of 32 negatives into a single image, titled Two Ways of Life. VFX has developed tremendously since the days of Oscar Rejlander, and it is now used in almost every film that is made. CGI is one of the most important tools used in VFX, and it allows filmmakers to create realistic and immersive worlds and characters that would not be possible using traditional filmmaking techniques. It is one of the key reasons why VFX has become so important in modern film making. Toy Story (1995) by Pixar is the first feature-length film to be made completely with computer animation [2] [3].

With rapid advancements in technology and demand for visually appealing and realistic content, the animation and VFX industries are being revolutionized, with widespread applications in areas like advertising, education, along with film and web series production. Animation and VFX methods provide artists with creative freedom to create powerful stories with immersive world-building, character development, and storytelling [4].

2. OVERVIEW OF ANIMATION AND VFX PROCESSES

Animation and VFX are complex and ever-evolving fields, but the basic methods and processes remain the same. A better appreciation for the work that goes into creating the animated and VFX sequences that we see in films are gained by understanding the methods and processes involved. The animation and VFX workflow typically involve the following steps [5].

2.1 Pre-production

Pre-production is the initial stage of developing the concept and characters, scriptwriting, creating storyboards, which are rough sketches for the project. It also includes the analysis of the client requirements, budget, team- up, adapting the concept to a specific location, research and development, prototyping, concept art and style frames. This stage helps in visualizing the final product before beginning the project and is a crucial stage, as it lays the groundwork for the rest of the production process [6].

2. 2 Production

This stage involves creating the animated or CGI assets for the project. This may include processes such as modeling, rigging, animating, and rendering [6], some of which are listed below:

- Modelling - Modeling is the process of creating a 3D representation of an object (props) or character using specialized software. It is the first step in creating 3D animation and VFX [3].
- Rigging - Rigging is the process of adding bones and controls to a 3D model for animation, with the bones

controlling movement and the controls posing the model. Software simplifies this process by building skeletons, assigning weights, and scales to bones [7].

- Animating - The animation stage is the final step in creating high-quality animation, requiring careful planning and execution to create believable worlds and characters. It requires various skills and may involve additional processes like particle, fluid, rigid body, and cloth simulation. Tools in software applications aid in these simulations [6].

- Rendering - The rendering process involves generating a final image or video from 3D models and scene elements. The software reads the scene file, calculates lighting for each object, casts rays from the camera position to each pixel, and calculates the color of the pixel based on the object's color, lighting, and transparency. This process is repeated for each pixel in the image to generate the final image. The process ensures accurate and realistic visuals [7] [8].

2. 3 Post-Production

Post–Production work is the collaboration process where the raw footage is edited together and special effects are added. It can be a long and complex process, but it is essential for creating a finished product that is both visually and narratively compelling [5].

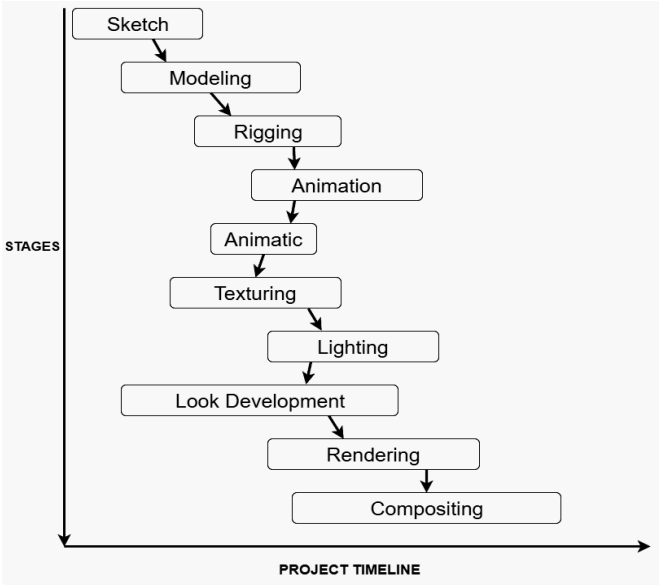

Fig - 1: Example of a visual effects pipeline [11].

- Composition and lighting: Different elements of the animation, such as characters, backgrounds and special effects are combined together to create a single frame. VFX artists need to be able to create images that are both visually appealing and realistic. This requires a strong understanding of how light and shadow work, as well as how to compose images in a way that is both balanced and dynamic [5].

- Color correction and color grading: These are the final steps in the post-production process. Color correction is the process of fixing any lighting or color issues in the footage so that it looks natural and realistic. Color grading is the process of adjusting the overall look and feel of the footage to create the desired mood and atmosphere [5].

- Editing: The individual shots are trimmed and assembled into a sequence. The special effects and transitions are added in this phase. Lastly the pacing and rhythm of the animation are finalized [7].

3. ANIMATION AND VFX TECHNIQUES

- Traditional Animation - Traditional hand-drawn animation, also known as cel animation, involves creating animated sequences by drawing each frame on transparent sheets. Skilled artists meticulously sketch each frame, paying close attention to the flow of movement and character personalities. Walt Disney is a pioneer of this method, popularizing beloved characters and stories with films like "Snow White and the Seven Dwarfs" and "The Lion King"[9].

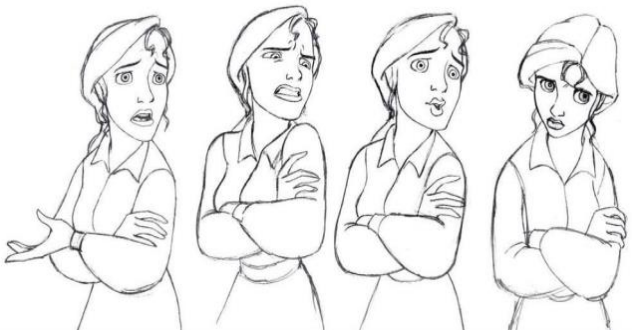

Fig - 2: Traditional animation [9].

- Stop motion animation - Stop motion animation, also known as 3D animation or puppet animation, is a technique that uses three-dimensional objects to create animated sequences. It involves interrupting the action frame by frame, making subtle adjustments to the puppets or objects between frames. The articulation of joints is carefully considered to mimic the natural movements of the human body. This technique is also used to create animated sequences with clay figures, known as Claymation, trademarked by Will Vinton Studios [10].

- Computer animation – Computer animation (CGI) is a popular tool in filmmaking, allowing filmmakers to add digital elements to real-life footage, including

landscapes, characters, and effects. CGI can create both 2D and 3D elements, with 3D being most commonly used. It enhances existing footage and creates more realistic and immersive experiences, making it an essential tool in various film genres [11].

Fig - 3: Stop motion animation [9].

- Hybrid animation - Hybrid animation is a popular technique used in the multimedia industry for creating cartoons and short stories. It combines 2D and 3D measurements on a flat plane, offering easier object creation and manipulation.3D animation offers advantages like ease of camera motion, complex lighting, realism, and high reusability. Motion capture, also known as performance capture, is used in various fields [12].

- Matte painting - Matte painting is a crucial aspect of filmmaking, creating realistic and immersive cinematic worlds. Traditional hand-painting is time-consuming and labor-intensive, making it less practical for modern production. Digital technology has revolutionized matte painting, offering powerful tools for creating stunning backgrounds and 3D modeling and rendering techniques for highly detailed environments [11].

- Rotoscoping – Rotoscopy is a method of creating alpha mattes by manually tracing around an object or character, determining visible and transparent parts of the image. This process involves creating a mask that follows the object's movement, which can be generated using computer points or manual work [11].

- Motion capture - Motion capture technology is crucial in film and television animation production, complementing each other. It emerged due to high demand and has expanded to include multimedia, games, and film and television. This technology reduces the workload of traditional manual editing in animation creation [13]. It involves recording real actors' movements and facial expressions using specialized suits. This data is then transferred to a 3D model, which can be used to create characters and creatures by altering their physical appearance through digital processing [11].

- Extended reality - Extended reality (XR) is a virtual technology used in creative filmmaking, encompassing Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR). It enhances our view of the real world, replaces user's view, and blends real-world environments with computer-generated objects. XR is continuously developing in human-computer interactions, offering immersive experiential solutions for potential virtual productions.

Fig – 4 :Body motion capture[14].

It is essential for pre-production, production, and post-production in the creative industry [15].

4. EXPLORATION OF ANIMATION AND VFX SOFTWARES

4.1 Maya

Maya is 3D computer graphics software that is widely used to create 3D applications such as visual effects, animated shorts and films and even video games. Despite its complexity, Maya finds widespread uses due to its versatility. It has been used in many award-winning feature films, such as Disney's Frozen, Pixar's Brave, and Rupert Sanders' Snow White and the Huntsman. There are two ways to use Maya: (1) using the tools that Maya already comes with, and (2) scripting in either MEL (Maya Embedded Language) or Python.

To create the character model, the animator needs to upload the character's sketch onto Maya and then manipulate the polygonal and non-uniform rational b-splines (NURBS) modeling features to create the model's body. Then, there is provision to add lights, colors, materials, and textures to the character. Next, the animator can use Maya's HumanIK tool to rig the character. Finally, Maya's nParticles tool can be used to create particle simulations for the character [7].

4.2 Blender

Blender is free, open-source 3D software that can be used to create animations and movies. It is similar to Maya, but it is easier to use. Blender includes many of the same features as Maya, such as sculpting and rigging tools, UV and camera manipulation, library extensions, and particle simulations [7]. Blender also has a user-friendly interface that makes it easy to learn and use. With Blender, it is possible to create animations with realistic materials, lighting, texturing, foam simulation, motion blur, and compositing [16]. A scripting interface that can be used to convert data from previous stages of the animation process into 3D environments is provided in Blender. It also has a built-in video sequencer that can be used for basic video editing tasks [17].

Advanced users employ Blender's API for Python scripting to customize the application and write specialized tools; often these are included in Blender's future releases. Blender is well suited to individuals and small studios that benefit from its unified pipeline and responsive development process [16].

4.3 Nuke

Nuke is a node-based visual effects compositing software from The Foundry. It is widely used in film and television post-production for editing video clips and image sequences. Nuke offers a robust node-based workflow, multichannel editing, stereoscopic workflow, particle system, chroma keying and the ability to be extended with plugins. Nuke can be extended with external plugins written in Tcl, C++, or Python (supported since version 5)[18].

4.4 Houdini

Houdini is node-based 3D animation software known for its versatility and procedural tools. It offers a visual programming environment where artists can create custom tools to streamline their workflows. Many visual effects studios use Houdini end-to-end. Houdini comes with HScript, an older scripting language that is still used for compatibility with older projects. HScript is similar to MEL in Maya. It can be used to script object transformations, edit light properties, and modify render outputs, but it is not as efficient for modifying geometry or performing point-related operations. For geometry and point operations, VEX is the more practical solution. VEX is a powerful scripting language that is built into Houdini and is specifically designed for working with geometry and points [18].

4.5 DualSPHysics

DualSPHysics is a free software package for simulating fluids using the Smooth Particle Hydrodynamics (SPH) method. It is highly optimized to run on parallel architectures such as GPUs and multi-core CPUs. DualSPHysics also includes several post-processing tools to visualize the simulation results in the form of points or isosurfaces. The output files are in the VTK (Visualization ToolKit) format. A Blender plugin has been developed to allow users to import and work with DualSPHysics simulation data in Blender. The plugin updates the data and object properties at each time step, allowing users to render realistic animations of the simulated fluids [16].

5. FUTURE SCOPE AND CONCLUSION

The media industry is rapidly changing due to digital media convergence and the 4th Industrial Revolution. This is creating new opportunities for content creators and distributors, but it is also challenging them to produce high-quality content at a lower cost and faster pace [19]. Animation and VFX techniques are now used in almost all types of media, including movies, web series, advertisements, educational videos and video games with high-quality graphics and animation.

In the future, animation will rely not only on artistic techniques, but also on physics simulations and an understanding of physics. Education in the field of animation must continue to evolve to keep up with these technological advances. Furthermore, the development of trends like VR and AR will create demand for animation and VFX content specifically designed for these immersive platforms, and the increasing use of AI and machine learning in animation and VFX will lead to the creation of more realistic and believable characters and environments [2][20].

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