

CINEMA AND IT

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The principle types of visual effects are considered. The technology of their creation is discussed. The applications and software used in production are analyzed.

The history of Visual Effects began back in 1857 when Oscar Rejlander combined sections of 32 negatives into a single image to create the world's first "special effect" image. Since then, technologies of Visual Effects have developed enormously and today you can hardly find any movie, produced without using multiple techniques of VFX [1].

The abbreviation VFX stands for "visual effects" – the term that describes imagery created by combining life-action footage with CGI (computer-generated imagery) to get a holistic picture, as close as possible to the real one. In fact, the goal VFX-artists face is to make fake objects look real. Moreover, no matter what tools they use, CGI is the key aspect in major cases.

CGI combines all the graphics created by computer only: 2D or 3D animations, objects, or renderings. The brightest examples to show its significance are fully animated movies [2]. Therefore, Toy Story (1995) by Pixar that became the first CGI movie done completely with computer animation, Antz (1998) and Shrek (2001) by Dreamworks, Despicable Me (2010) and The Secret Life of Pets (2016) by Illumination, etc. [3].

Apart from this, CGI has numerous areas to be widely used in cinema:

Static images and landscapes: natural looking landscapes can be generated via computer algorithms. A simple way to generate fractal surfaces is to use an extension of the triangular mesh method. For instance, the algorithm may start with a large triangle, and then recursively zoom in by dividing it into four smaller Sierpinski triangles, and then interpolate the height of each point from its nearest neighbors.

Architectural models: 3-dimensional models allow visualize a space, perform "walk-throughs" in an interactive manner, and can be used to "reconstruct" historical buildings.

Cloth, fur and skin images: The challenge in rendering human skin images involves following levels of realism:

- photo realism that resembles real skin at the static level;
- physical realism that resembles its movements;
- function realism that resembles its response to actions [4].

The finest visible features such as fine wrinkles and skin pores are the size of about 100 μm or 0.1 millimeters. Skin can be modeled as a 7-dimensional bidirectional texture function (BTF) or a collection of bidirectional scattering distribution function (BSDF) over the target's surfaces.

2D models that include various text-lines, backgrounds, backdrops and other objects.

3D models that include numerous objects like models of people, monsters, buildings, cars, explosions etc. that are put into a live-action scenario, such as a monster attacking a city or a car being blown up by an explosion. These types of CGI effects are commonplace and are often seen in high profile productions [5].

It is notable, that computer-generated imagery is used by the vast majority of VFX techniques. Now let us pay more attention to their variety [6]:

Optical special effects are techniques in which images or film frames are created photographically by using multiple exposure, mattes or Schuffan process. Optical can be used to place actors or objects against different background.

Matte painting refers to a painted representation of a landscape or distant location. The environment is static. All the movements and animations are integrated on it.

Compositing is the combining of visual elements from separate sources into single image. Compositing is widely known as "Chroma key", "Green screen" or "Blue screen". Today compositing is mostly achieved through digital image manipulation.

Rotoscoping is an animation technique used for tracing over motion picture footage, frame by frame, to produce realistic action. In the visual effects industry, rotoscoping is the technique of manually creating a matte for an element on a live-action plate so it may be composited over another background.

Match-moving is a technique that allows the insertion of computer graphics into live-action footage with correct position, scale, orientation. Match moving is typically a software-based technology used to track the movement of a camera through a shot.

Skeletal animation (rigging) is a technique in computer animation in which a character is represented as mesh (skin) and a hierarchical set of interconnected parts called bones forming skeleton (rig), a virtual armature used to animate the mesh. The technique can be used to control the deformation of any object the set of "bones" may not be hierarchical or interconnected, but simply represent a higher-level description of the motion of the part of mesh it is influencing.

Motion capture (mocap) technology is used to record movements and apply them to a 3D model. Physical mocap suits, specialty cameras, and advanced software are used to create photorealistic animations. Examples of motion capture are Thanos — Avengers: Endgame,

Smaug – The Hobbit: The Desolation of Smaug or Gollum – Lord of the Rings [7].

The four main types of Motion capture can be defined:

Retroreflective suit markers & infrared cameras (optical-passive) – markers are placed on actors' tight suit and tracked via infrared cameras.

LED suit markers & cameras (optical-active) – Light-emitting LED markers are placed on actors the same way as optical-passive tracking, and special cameras record their movement.

Video (Markerless): A sophisticated camera stage is used – Instead of using markers; the acting area is covered by a grid on the floor and a network of cameras shooting from every possible angle.

Inertial (Cameraless): Motion sensor suit – Unlike the other types, this requires no cameras. Instead, inertial sensors (IMUs) are worn by the actor. The motion data is transmitted wirelessly to a nearby device. The gyroscopic motion sensors record the angle, position, and momentum of your body and accurately transcribe it into animated movement [8].

Visual Effects software is using various programming languages like C, C++, C#, Java, CUDA, Perl, Lua, MAXScript, MEL (Maya Embedded Language). Meanwhile, the most common one is Python, as it is based on Object Oriented Programming, which makes it pretty flexible and powerful to run either as standalone script or as getting integrated in native software coding.

Effects can be created due to diverse choice of contemporary software:

Adobe After Effects;

Maxon Cinema 4D;

Autodesk Maya;

Syntheyes;

3Ds Max;

Houdini;

Boujou;

Mocha, etc.

To summarize, Visual IT technologies are widely used in modern cinematograph, especially for creating versatile visual effects. VFX are used to achieve inexistent, or expensive to use in reality environments, picturesque places, animals, etc. The usage of modern software helps to reduce costs, danger for health or life of actors, shorten time spoiled on creating hand-made decorations.

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