The evolution of visual effects technology over the past 22 years has resulted in significant changes to the special effects in the "Matrix" series of films.

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Abstract

The Matrix film, released in 1999, won the Academy Award for Best Visual Effects due to its utilization of advanced visual effects technology. The film and its subsequent series, including The Matrix Resurrections, released in 2021, continue to utilize visual effects technology and special effects photography techniques to create impressive visual elements. This paper will examine the visual effects featured in The Matrix and The Matrix Resurrections, and briefly analyze the progression and innovations in the use and production of visual effects in the "Matrix" film series over the course of 22 years.

Key Words

The Matrix, Visual Effects, Bullet Time, Virtual Cameras, Unreal Engine

Contents Page

Introduction	1
Literature Review	2
Chapter 1 – The Matrix and Bullet Time	2
Chapter 2 – The Matrix Resurrections and Unreal Engine	3
Chapter 3 – Advances in Visual Effects	4
Conclusion	5
Bibliography	7

Introduction

Since the late 1970s, cinema has evolved and integrated with other media technologies. As a visual medium, cinema is the result of the combination of various technical and artistic disciplines. In the past three decades, computer graphics technology and 3D have become widely used in film, video games, animation, visual exhibits, and other media (Mendiburu and Mendiburu, 2009 9, p. 2). The incorporation of computergenerated imagery in film has become the norm in the industry and is a significant marker of the post-cinematic era of cinema. Many popular films and commercial videos of this period have blended keyframe animation with live-action footage. This type of visual work involves converting live-action images into a digital format that can be processed and modified by a computer. These images can then be seamlessly combined with computer-generated elements, such as 3D models of characters and environments, to give the final composition a realistic appearance with a high degree of color and lighting similar to that of traditional film. Due to the increasing demand for such composites and the need for all background elements to be digital, live-action cinematography is often filmed using green screens. At this stage of production, films may feature virtual digital backdrops and special effects, with the exception of the actors and some physical props, which allow for the depiction of unrealistic battles and settings using non-realistic weapons and magic (Whissel, 2014, p. 1). This essay will examine and illustrate the iconic visual effects techniques and production used in The Matrix and The Matrix Resurrections and how they represent the evolution of visual effects in cinema.

Literature Review

The concept of computer-generated imagery (CGI) and its evolution over time is discussed in detail by Mendiburu (2009) in his book "3D Movie Making: Stereoscopic Digital Cinema from Script to Screen." This analysis forms the basis for the examination of the visual effects in The Matrix films in relation to different periods. Dave 's (1999) work "Better than SFX" provides a thorough explanation of the theory of "persistence of vision" and how it relates to the creation of the "bullet time" effect. Wanda Strauven (1999) referred to the visually striking effects in The Matrix, such as "bullet time," as "cinema of attractions." This concept, as summarized by Strauven, posits that the visual effects in The Matrix are designed to present discontinuous visual spectacles. The combination of these impressive visuals with the unique cinematic narrative contributed to the success of The Matrix in 1999. More recently, in the production of The Matrix Resurrections, Double Negative Visual Effects employed cutting-edge Unreal Engine technology, as described by Huw Evans, the visual effects supervisor at the company, in an interview with Ian Failes (2022). This allowed DNEG to utilize a new approach in creating the effects for the film.

Chapter 1 – The Matrix and Bullet Time

The Matrix, a science fiction film directed by the Wachowski siblings and released in 1999, won the Academy Award for Best Visual Effects due to its 412 special effects shots. The "bullet time" sequence, in particular, has gained recognition as one of the most iconic and well-known visual effects in the film. The technology behind motion picture photography is based on the concept of "persistence of vision," whereby the camera captures a subject continuously at a high frame rate, such as 24 frames per second. When played back, these images are merged together by the viewer's eye, creating the illusion of continuous motion. Similarly, a cinema camera captures a large number of images over an extended period of time at a high frame rate (Dave, 1999). With advancements in technology, the frame rate is no longer limited to 24 frames per second and can now reach 30, 60, 120, and even 240 frames per second. Bullet time utilizes this by capturing all the images in a short period of time from slightly different camera positions. In The Matrix, the special effects team used 120 cameras arranged in a circle to capture the images at fractional second intervals, which were then combined to give the viewer the impression of being shot by a single camera. (Simon, 2022) These 120 images captured in a few seconds were played back at a frame rate of 24 frames per second, creating the bullet time effect. While normal filming and the human eye are accustomed to seeing moving objects in real-time, the bullet time filming method involves the camera moving quickly around the subject in a short period of time, creating the impression that time is passing at a slower rate while allowing the viewer to observe the almost frozen subject in detail.

Chapter 2 – The Matrix Resurrections and Unreal Engine

The Matrix Resurrections, the fourth installment in the Matrix series released in 2021, has once again brought attention to the advancement of special effects in film and television over the past 22 years through its 2,350 special effects shots. In contrast to

The Matrix, which was shot in 3D using Maya software, The Matrix Resurrections utilized more advanced techniques and technology. One iconic scene in The Matrix involves Morpheus teaching Neo kung fu in a dojo. According to an interview with Ian Failes, director Lana Wachowski wanted to recreate this scene and its graphics in The Matrix Resurrections, specifically setting the dojo on a lake in the middle of a forest. This specific requirement posed a challenge for traditional effects shooting methods and software. To overcome this, Lana Wachowski, Huw Evans, the visual effects supervisor at Double Negative Visual Effects, and Epic collaborated on Unreal Enginerendered scenes for the film. The Unreal Engine was used to create all aspects of the film's environment, including lakes, bridges, forests, as well as camera, lighting, and shaders. This allowed for real-time rendering of the scenes, a capability that was not previously possible in VFX production. This allowed the effects team to continually refine the look of the scene and achieve a high level of detail and realism. This is first time that Double Negative Visual Effects has used a modern game engine for a complete sequence in a feature film (Failes, 2022).

Chapter 3 – Advances in Visual Effects

In the past two decades, there has been significant progress in the field of visual effects technology, with new software and techniques constantly emerging. As a result, the special effects that were groundbreaking in 1999 and earned Oscar recognition may now be considered standard in contemporary films. Advanced engines can now be used to realistically simulate a variety of effects, such as flowing water and lighting, with a

high level of detail and realism. The advancement of special effects technology over the past 20 years has also had a significant impact on the way in which these effects are produced, making the creation process more efficient and effective. As technology and software continue to advance at a rapid pace, the film industry is able to create more realistic and detailed special effects through the integration of game engines and cinematic techniques (Jurgensen, 2021). This has led to the emergence of innovative approaches and significant progress in the field of visual effects. The combination of game engines and cinematic special effects is just one example of this trend, which is set to continue in the future.

Conclusion

The Matrix film series, directed by the Wachowski siblings, has gained widespread acclaim for its innovative and visually impressive special effects. One of the most iconic and well-known of these effects is the "bullet time" sequence, in which the perception of time is slowed or stopped through the capture of a series of images at a high frame rate from slightly different camera positions. The Matrix Resurrections, the fourth film in the series released in 2021, employed the latest Unreal Engine technology and featured 2,350 special effects shots in order to recreate and update the iconic "bullet time" scene and other visual effects. Double Negative Visual Effects, the company responsible for the film's special effects, made history as the first to utilize a modern game engine for a complete sequence in a feature film. The advancements in technology and software, such as Unreal Engine, have allowed for the creation of more realistic

and detailed special effects and have transformed the way the film industry approaches their production. The combination of impressive visual effects and engaging cinematic storytelling has kept the Matrix series successful 22 years after its initial release. The Matrix film series is one instance of the rapid evolution of visual effects in recent years. The integration of game engines with cinematic visual effects is a particularly innovative development in this field. This is indicative of the potential for further advancements and innovations in the realm of visual effects across a variety of industries.

Word count: 1451

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