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Transformation of Film Directing and Cinematography through Technological Advancements: Focusing on Ang Lee's Films

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Abstract

This paper discusses the technical exploration of Ang Lee's cinematic works and the unique visual beauty he presents. Ang Lee has successfully tackled various themes and genres, creating films that harmoniously blend Eastern and Western cultural sensibilities. These films are technologically innovative and show the interaction between technology and art, industry and culture. Therefore, this paper analyses the correlation between film technology and visual beauty in Ang Lee's works, and explores the discourse on how the relationship between film technology and art has changed with the development of film. Furthermore, this paper aims to provide insights into how technological innovation can enhance artistic creativity. The contribution of this study lies in the in-depth exploration of the relationship between film technology and art, with a focus on technological innovation and the visual beauty in Ang Lee's works. The research findings reveal that Ang Lee's films showcase the application of advanced technologies, captivating audiences with their unique visual aesthetics. The utilization of emerging technologies enables his films to possess not only visual impact but also convey profound emotions and themes. We conclude that technological innovation in film not only provides artists with more creative tools and expressive techniques but also, when combined with artistic sensibilities, creates captivating and visually expressive cinematic works. This discovery offers a new perspective for film production and opens up greater possibilities for collaboration between artists and technology experts.

Keywords: Ang Lee, Film Technology, Film Art, Cinematography, Technical Innovation.

1. INTRODUCTION

1.1 Necessity and Purpose

The modern film industry has undergone rapid changes due to the rapid development of film technology, which has had a significant impact on the visual aesthetics and narrative structure of films over time. The technology used in film production has continuously evolved from the past to the present, and has played a crucial role in the study of film theory and aesthetics. Although various previous studies have examined the technological aspects and changes in the film industry, there has been a lack of in-depth analysis regarding the

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impact of applied film technology on the visual aesthetics and narrative structure of films created by individual directors. The development of film technology has influenced films in different ways, depending on the genre of the film and the directing style of the director. As a result, changes in film technology have directly influenced not only the film production process, but also the creative methods of directors and the way that audiences enjoy films [1]. Therefore, this study aims to explore the paradigm shift in Ang Lee's directing aesthetic based on the development and changes in film technology, and to examine his unique visual aesthetics and creativity.

Ang Lee is a director renowned for his original directorial aesthetic in the Taiwan film industry. His works have gained worldwide recognition for their unique visual aesthetics and narrative structure. Ang Lee's works have incorporated both traditional and digital film technology to create a distinctive visual aesthetic. This study will examine the characteristics of film technology used in Ang Lee's works, including directing, shooting, and changes in visual aesthetics. Examining the influence of film technology on the visual aesthetics and narrative structure of films through Ang Lee's works will help understand the specific effects of changes in film technology on film production and aesthetics. This study will also play a crucial role in understanding the overall changes and trends in the film industry related to film production. Furthermore, by examining how Ang Lee overcame the limits of aesthetic expression in existing films, this study will contribute to understanding the changes in his film philosophy and visual aesthetics.

1.2 Scope and Methodology

The scope and method of this research are as follows. First, from the perspective of the research objective, this paper examines the aesthetic characteristics and values of Ang Lee's digital films by examining his works from the perspective of the development of film technology. By doing so, it will be possible to systematically explain Ang Lee's exploration of digital technology and clearly distinguish the directing methods that have emerged after the digital transformation. In addition, it will be helpful in expanding the scope of research on Ang Lee's film aesthetics. Second, from the perspective of research content, this study combines the theoretical foundation of the philosophy of technology and aesthetics with the visual aesthetics of film media, based on a detailed summary and interpretation of Ang Lee's film aesthetics. By discussing the identity of films in the "post-film era", it obtains the necessary data to discuss the influence of the development of film technology on the essence of films and to propose the direction of film research [2]. Finally, from the perspective of research results, this paper analyzes the changes in Ang Lee's visual aesthetics according to the changes in film technology, and systematically categorizes the differences between his films and digital aesthetics. Through this, it will be possible to summarize the impact of the development of film technology on the film industry. This research uses a text-based research method and analyzes Ang Lee's visual language based on specific film content to understand the changes in film technology and visual aesthetics, and to analyze the changes in visual effects and aesthetic effects.

2. THE CINEMATIC TECHNIQUE AND ANG LEE'S FILMS

2.1 Technological Characteristics of Films

The production technology of cinema has made great progress, from traditional mechanical and film-based technology to digital technology, which has brought about many changes in the aesthetics of film. As a medium that combines culture, art, and science, movies were shot on film before the 1990s. However, with the development of digital technology, digital cameras replaced film cameras, as well as all related shooting equipment and post-production techniques underwent digital innovation. As a result, unprecedented new visual

scenes could be created. Comparing the aesthetics of film from the era of traditional mechanical technology with that of film based on digital technology, there are significant differences in the nature of cinema, the subject matter and imagination of cinema, and the expansion of the spatiotemporal dimension of cinema. James Cameron(1954~), a famous American film director, said that today's visual entertainment production technology is undergoing significant changes, and that these changes have brought about many changes in the way movies and other visual media are produced, which he called the "digital art Renaissance". It is not an exaggeration to interpret this to mean that the driving force behind the development of movies today is the increasing influence of film technology [3].

When digital video technology first appeared, people focused mainly on creating unrealistic scenes and emphasizing the visual effects of video. At that time, the aesthetic significance of digital video was not a major consideration. However, as digital film production technology and post-production and compositing technology advanced, they not only changed the way films were made, but also began to shape the psychological reception of audiences and form a more diverse range of cinematic aesthetics. Film technology and art can be seen as a complementary and evolving relationship. For example, early films were simply a record of simple scenes, but with the development of montage editing techniques, the montage video aesthetic emerged, and with the development of lens technology, video could evolve into a visual art form capable of expressing different angles and depths. Film sensitivity technology made it possible to produce videos with fast movements, and camera movement technology made it possible to create more dynamic visual aesthetics. More recently, the emergence of immersive movies using computer graphics has created new visual effects and aesthetics that were previously unseen [4].

To study film technology, one must pay attention to the technological attributes of film and its historical evolution, and based on this, must aesthetically organize the relationship between film technology and art. Film is considered as one of the most active cultural industries of our time, a visual record reflecting contemporary narratives and psychological worlds, and a great asset of humanity. Film is an art that conveys stories through visual language, and the audience enjoys all visual stimuli that appear on a large screen through sight and hearing. Due to this characteristic of film, filmmakers have concentrated on visual expression, leading to the development of various visual media such as color film, digital film, 3D stereoscopic film, virtual reality (VR), augmented reality (AR), and more, which have formed a large industry structure [5]. These important changes in the film industry are all connected to the development of film technology and have become the driving force to increase the competitiveness of the film industry.

2.2 The History of Film Technology within Ang Lee

Ang Lee, is one of the few filmmakers who has experienced the glory of traditional film from the era of film to the era of digital film, and has actively participated in the exploration of digital film. His films have continuously evolved with the advancement of visual technology, showing a diverse range of visual spectrums over time. His early films were mostly made using traditional film techniques. Works such as "Pushing Hands", "The Wedding Banquet", "Eat Drink Man Woman" and "Sense and Sensibility" dealt mainly with family issues and exploration. Ang Lee's recognition of the value of these early films made him one of the most acclaimed directors in Hollywood. In 2000, his work "Crouching Tiger, Hidden Dragon" showcased his unique technical visual aesthetic. The film is known for its wire action and various fight scenes, as well as its overall vivid color composition. This was made possible by the development of wire action technology and film post-production techniques. As a result, the film won the Best Foreign Language Film Award, the Cinematography Award, the Art Direction Award and the Music Award at the 73rd Academy Awards, becoming the first Chinese-language

film to do so[6].

As we enter the 21st century, the film industry has begun to incorporate digital technology into its productions. Ang Lee also took on the challenge of using digital film techniques for his movies. A case in point is the 2003 film "Hulk". Ang Lee utilized computer graphics to recreate the surreal Hulk character, and the vivid expressions portrayed by the Hulk were expressed as a new visual beauty. In 2007, Ang Lee delved into the world of digital intermediate (DI) technology for the first time while shooting Lust, Caution. Two years later, the avant-garde film Avatar was released, ushering in the era of 3D movies. The film, directed by James Cameron, inspired Ang Lee greatly, leading him to unveil his first 3D film, Life of Pi, three years later. This film also employed advanced computer-generated (CG) techniques, which Ang Lee had acquired from his previous experience on Green Lantern. At the 85th Academy Awards, Life of Pi won four awards, including Best Director, Best Cinematography, Best Visual Effects, and Best Original Score [7].

In 2016, Ang Lee made a giant leap in the field of film technology with "Billy Lynn's Long Halftime Walk", which was shot at the unprecedented speed of 120 frames per second. This technical innovation and fusion of film language greatly enhanced the realism, visual impact, and emotional expressiveness of the screen. 120fps+4K+3D offered viewers a visual feast, creating an instant and immersive cinematic world. In fact, movies have been shot at 24 frames per second since the 1930s, based on the principle of human visual persistence. Gemini Man used "digital actor" CG technology to allow the simultaneous appearance of a 50-year-old Henry Brogan (played by Will Smith) and his younger clone (played by a younger version of Will Smith). This allowed for the replication of a younger version of Will Smith through digital technology.

3. CINEMATOGRAPHY AND TRANSFORMATION OF VISUAL AESTHETICS

3.1 Changes in Cinematography Techniques: Scene Composition

Director Ang Lee's early films used traditional filming and production methods to explore themes of family culture and ethical concepts through the language of images. In his early family trilogy, including "Kung Fu Instructor," "Marriage Celebration," and "Eat Drink Man Woman," As shown in Figure 1(a), Ang Lee preferred to use static images with no camera movement, focusing on capturing the dialogue and actions between characters to develop the overall story. Scene selection was mainly medium or close-up shots, with directing emphasis on the dialogue scenes between the characters who were the narrative subject of the story. During this time, all films were shot on film, which created a unique artistic visual aesthetic with color and lighting that is unmatched in digital cinema. As a result, Ang Lee became a celebrated film director in Taiwan. However, due to the limitations of the Taiwanese film market, there were restrictions on his creative filmmaking.

"Sense and Sensibility" marked the directorial debut of Ang Lee in Hollywood. At that time, American movies led the global film market based on huge capital. However, Ang Lee did not agree with the blockbuster-oriented Hollywood filmmaking method, and instead brought the artistic framework of European cinema to create "Sense and Sensibility" [8]. This was a realistic compromise as a filmmaker considering the reality of the Hollywood film industry and the demand of the movie market. In this film, Ang Lee demonstrated a distinct visual aesthetic and established his own aesthetic ideology. The film poetically expressed time, space, and the movement and stillness of characters through smooth scene transitions and varied screen compositions rather than long, fixed frames. To achieve this, he used techniques uncommon in traditional films, such as long takes, wide shots, and blank scenes without characters. As shown in Figure 1(b), These technical elements allowed a poetic representation of time and space, which was the strength of the film, and allowed a story with a richer narrative structure to unfold.

Ang Lee's movie "Crouching Tiger, Hidden Dragon" presented a unique visual beauty of battle scenes by

*Mix of
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reinterpreting the wire action technique. In the past, the limitations of screen composition were significant because actors performed in a weightless state during wire action scenes. Therefore, the predominant method was to use close-ups of the upper body to minimize the illusion [9]. However, director Ang Lee introduced creative ways to overcome these limitations. As shown in Figure 1(c), He developed a special camera frame that moved with the actors, allowing aerial combat scenes to be filmed. As a result, long-distance scenes of the bamboo forest battle could be beautifully depicted with a composition similar to Eastern paintings. With this example, director Ang Lee is actively responding to the development of film technology and exploring new possibilities in film production. The bamboo forest battle scene in "Crouching Tiger, Hidden Dragon" can be regarded as a work in which his creativity and technical ingenuity are combined, and it has opened up new horizons for wire action technique.



Figure 1. Changes in Cinematography Techniques

3.2 Changes in Spatial Technology: 2D and 3D

In 2009, the release of the movie "Avatar" seemed to herald a transition from 2D to 3D in the movie industry, leading to a surge of interest in 3D technology. 3D movies are a medium that transcends the limitations of the screen and provides audiences with a three-dimensional sensation, and this has given rise to a new visual style based on "visual stimulation" using 3D technology. As a result, 3D stereoscopic film technology and powerful CG technology have become central to film production, exerting a significant influence on the creation of visual beauty [10]. Director Ang Lee did not miss this trend, and his first 3D movie, "Life of Pi", released in 2013, received an enthusiastic response from both film critics and the general public. Through this film, we can catch a glimpse of Ang Lee's interest and philosophy regarding 3D movies, as well as his unique directing style. Ang Lee's attitude towards film technology is one of "balance". He has not overused 3D technology to create stereoscopic movies. This philosophy seems to be his own groundbreaking solution to avoid the mistakes that can occur when relying too heavily on film technology.

"Life of Pi" is a movie that tells the story of a 17-year-old boy who spends 277 days in the Pacific Ocean with a Bengal tiger. Ang Lee used CG technology to tell this story perfectly, which had been difficult to do with real images. In addition, he used stereoscopic technology to create scenes that were as close to reality as possible for the audience, perfectly capturing his artistic sensibility on the screen. Ang Lee's unique directing style can be seen in many scenes throughout the movie, including fantastic and shocking ones. In particular, the various scenes, such as the sea, the island, the church, the hometown, the stars and the sky, present an amazing level of realism in visual beauty. Due to the difficulties of shooting on the actual ocean, the film crew shot in the controlled environment of an artificial pool. They used a device that creates artificial waves to create different wave patterns and stage vivid scenes of the ocean. In addition, through the application of CG technology and 3D imaging, the underwater ecosystem was depicted in a mystical manner, while scenes of the starry night sky, moon, clouds, and more were portrayed with a strikingly lifelike quality. Furthermore, scenes of a forested island imbued with otherworldly beauty and a sense of enigmatic terror were shown, leaving a

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striking visual impact through a powerful combination of advanced CG technology and the creative prowess of Ang Lee. The poignant image of a tiger's back and a melancholy smile reflected on Pi's face in the final scene was an extremely profound moment, highlighting the exceptional filmmaking and artistic ingenuity brought about by the fusion of filmmaking and artistic creation.

3.3 Digital Video Technology: Post-production editing, Image compositing, CGI

Director Ang Lee incorporated his unique style into his film "Hulk" while adhering to the typical Hollywood movie style. Using various visualization techniques, including post-production editing and computer-generated imagery (CGI), he created a distinctive visual beauty. The movie "Hulk" was Ang Lee's first attempt to adapt a comic book into a movie, a genre that inevitably requires computer graphics technology. In particular, CGI was a key element in solving the narrative challenges while serving as a striking technical feature of the film [11].

From the beginning of the film, Ang Lee constructed creative visuals using a single scene from the virtual space of comics. He also used subtitles following the style of the original comic to lead the audience's immersion in the characters and story. Ang Lee utilized screen split techniques to simultaneously express multiple scenes and structured the screen in a grid format similar to that of comics. As shown in Figure 2(a), in a scene where the protagonist Bruce meets other characters, he effectively showed the situation occurring simultaneously by dividing the screen into three parts. Through this method, the emotions and psychological situations of each character were delicately depicted. Additionally, this film used fast-paced video editing techniques to increase the film's pace and tension. Various camera angles were used to quickly show the same scene from different perspectives, integrating them into a single screen and delicately depicting each character's emotions and situation. These digital video editing techniques enabled Ang Lee to create more realistic visual effects and action.

The technique of digital image synthesis offers a more visually rich and innovative on-screen display because it is not limited by the limitations of regular camera lenses and can provide a wider field of view. In the movie "Life of Pi", the scene of the convergence of sky and sea was repeatedly depicted using advanced post-production image synthesis technology. Figure 2(b) shows the reflection of the sky's scenery on the ocean was achieved through symmetric reflection, with the protagonist situated on the vast expanse of the sea. Such scenes undoubtedly bring about a sense of realism and visual appeal. The modeling of three-dimensional space is also able to enhance the depth perception of the movie scenes and create an illusion of reality that offers a more authentic movie-going experience [12]. Meanwhile, Ang Lee successfully implemented CGI technology as an important technical element in movie "Hulk" to enhance immersion by smoothly realizing the interaction between the virtual character, Hulk, and the surrounding environment. In particular, Ang Lee used motion capture technology to create more natural movements for the Hulk. One of the most significant features of this film is that the creation of the character, which has a human-like shape, through the new visual technology that applies human body movement information to the character, shaping the narrative structure of the film. This film is Ang Lee's first attempt in Hollywood's action and science fiction film genre, and although it did not achieve great commercial success, it is an important work that demonstrates his understanding of the Hollywood film model and his determination to explore film technology [13].

3.4 The Evolution of Screen Ratios: From 4:3 to Widescreen Ratios

The freedom of the aspect ratio is a characteristic that distinguishes film from other 2D arts such as painting. Widescreen gives the audience the feeling of seeing reality with their own eyes. Widescreen technology emerged in the 20th century and quickly became an important technological element in creating a sense of

Possible

limitation? / problem?

realism for filmmakers and audiences alike. The aspect ratio also played an important role in the aesthetics of film. With widescreen technology receiving much attention in the technical category at the Academy Awards, major production companies abandoned the 4:3 aspect ratio they had been using. Widescreen technology is a good example of how technological advances interact with and influence the style and evolution of cinema. As this new technology was actively used in film production, filmmakers had to continually adjust and adapt to meet the demands of visual expression at the time. The problems that arise during the process of technological change serve as examples of potential aesthetic problems, or show that many aesthetic problems arise from technical problems.

There are two main ways to change the aspect ratio of movie screens. First, by covering the image area while recording or displaying and creating black borders above and below the video to adjust the ratio. Second, by transforming the video to make the screen wider. This is done by compressing the video captured with a transformation lens during recording, and then decompressing it with a corresponding lens during display. Due to various problems such as distortion of close-up shots, singularity of focus distance, and limitation of shooting backgrounds, directors who opt for a larger aspect ratio must go through corresponding adjustment processes. For example, they can compensate for the singularity of lens use by reducing the zoom lens and relying on the actors' movements. They can avoid focus problems that can occur with zooming by using a fixed lens for close-up shots. By arranging the screen layout and actor positioning on a wide screen, they can avoid distortion caused by camera movement and emphasize depth within the screen by showing diagonal movements of the characters[14].

IMAX and similar giant screens capture scenes from different movies and project them simultaneously onto a circular screen using multiple projectors. Such movies on these giant screens give viewers a greater sense of realism by greatly expanding their field of vision. The external and formal changes of these films have become even more diverse with the advent of the digital film era. For example, Ang Lee's early films mostly used a 1.85:1 format, but after he ventured into Hollywood, he used a wider 2.35:1 aspect ratio in films such as "Ride with The Devil" and "Crouching Tiger, Hidden Dragon." In particular, it is said that he chose a wider aspect ratio in "Ride with The Devil" to show vast landscapes and precise screen compositions. By choosing different aspect ratios according to the genre, content, and director's preferences, movies maximize their unique aesthetic effects. Therefore, the aspect ratio of a movie is closely related to its development history and is constantly changing in pursuit of its aesthetic value, following the advancement of film technology and the demands of the times. The evolution of aspect ratios provides audiences with new viewing experiences and serves as a driving force for the development of the film industry [15].

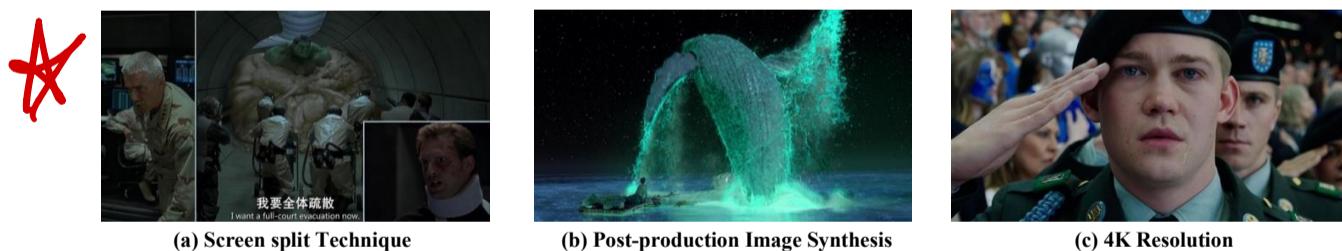


Figure 2. Changes in Digital and Post-Production Technology

3.5 The Changes in Resolution and Frame Rate: 4K & 120fps.

The films "Gemini Man" and "Billy Lynn's Long Halftime Walk" utilized the 120fps format. Especially, it was produced as a 4K resolution film. These technical formats helped to achieve a sharp and smooth visual

image that far exceeded the common frame rates used at that time. 120fps is capable of playing back 120 frames per second, making it sharper and helping to eliminate motion blur compared to the typical 24fps movie screen. During the filming of "Life of Pi," Ang Lee was inspired by various technical aspects of James Cameron's movie "Avatar," which introduced the 48fps frame rate technology. The success of "Avatar" became a catalyst for many filmmakers to increase their frame rates, and the application of high-resolution and high frame rate technology spread to many films, including Ang Lee's movies [16].

On the other hand, high-resolution and high frame-rate technology can aid in enhancing the visual quality of a film, but it also poses a significant burden in terms of equipment and infrastructure during the production process. For instance, higher frame rates require more powerful equipment and storage, and theaters must upgrade their projection equipment to accommodate the technology. Furthermore, more time and money must be invested in processing high-resolution images, and actors must bear the burden of delivering more detailed and nuanced performances due to high resolution and high frame rates, it is shown in Figure 2(c). For these reasons, some film researchers argue that high resolution and high frame rates can actually detract from the quality of a film and project unrealistic scenes that can negatively affect the viewing experience. However, despite these issues, 4K resolution and high frame rate technology have provided many moviegoers with stunning visual stimulation, and have had a positive impact on the growth of the film industry[17]. Therefore, changes in resolution and frame rate in the film industry have significant effects on the demand for film production and consumption. The development of such technology is constantly evolving throughout the film industry, and filmmakers strive to enhance the artistic and commercial aspects of their films through the adoption of new technology.

Advances in film technology have revolutionized the visual experience of cinema and contributed greatly to the resurgence of the film industry. Director Ang Lee has demonstrated his unique visual expression that combines Eastern and Western cultures, keeping pace with new technological advances, ranging from traditional film production techniques to the latest CGI in his films, from early cinema to recent works. In his early films, he developed the story using fixed frames and various perspectives, and created an artistic visual experience through the unique light and color of film. After entering Hollywood, he successfully implemented poetic spatiotemporal expression by introducing various screen compositions and techniques. His philosophy on film-making is to pursue his unique directing style by balancing technology dependence rather than relying on reckless technological dependence. Furthermore, he dramatically improved the visual effects and storytelling of the movie "Hulk" by utilizing excellent digital post-production techniques. The movie preserved the style of the original cartoon and used CGI technology to create a realistic Hulk. This allowed Director Ang Lee to lead differentiated changes in the film-making process and became an opportunity to highlight his own creative directing style. Finally, in the movies "Gemini Man" and "Billy Lynn's Long Halftime Walk," Director Ang Lee applied high resolution and a high frame rate of 120fps to provide astonishing visual effects in the movie. The introduction of such technology has increased audience immersion and enhanced the artistic and commercial value of Director Ang Lee's films.

4. CONCLUSION

The advancement of film technology has revolutionized the visual experience of cinema and has greatly contributed to the resurgence of the film industry. Director Ang Lee has exhibited his unique visual expression that combines Eastern and Western cultures, keeping pace with new technological advancements, ranging from traditional film production techniques to the latest CGI techniques in his films, from early cinema to recent works. In his early films, he developed the story using fixed frames and various perspectives, and created an artistic visual experience through the unique light and color of film. After entering Hollywood, he successfully

- Ang Lee director, known for starting out as a big director for the Taiwanese Film Industry and then continued to gain worldwide attention, and even making it to Hollywood with movies like *Life of Pi* Starring Dev Patel, the original Hulk movie in 2003, and *Brokeback Mountain*
- James Cameron, American director- called the new age of digital video production (without the use of physical film) "digital art renaissance", as it allowed for a multitude of visual effects that would allow directors to create more unrealistic scenes.

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Background - prior to 1990s film was made with actual film before digital era, when camera film was just getting started people stuck to more simple collections of scenes that were realistic and not very entertaining,

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implemented poetic spatiotemporal expression by introducing various screen compositions and techniques. We found that, Ang Lee has explored various film genres for almost 30 years, from his early works to his present pieces, leading the way in new technologies and aesthetic changes. His films create a unique visual world by harmoniously combining characteristics of both Eastern and Western cultures, and have elevated the value of the contemporary film industry. With an active attitude towards introducing new film techniques, he portrays his unique stories and characters, offering audiences fresh cinematic experiences. Ang Lee's accomplishments have driven the evolution of the ever-changing film industry, as he consistently challenges himself with new endeavors. His example can inspire future generations of filmmakers to understand and integrate the cultures of the East and West in their creations.

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Background:

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actual film before digital era,
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Started ppl stuck to more simple
collections of scenes that were
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, as tech innovation develops further
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top of innovation to incorporate it in
their films.

ANNOTATION

- Citation: in couple of chosen styles (IEEE, ACM, others)

- Key background: two to three bullet points identifying the theory/prior research on which the authors are building and defining terms.

- Data/ methods: one or two short bullet points with information about the source of the data and the method of analysis, with a note if this is novel or particularly effective example of that method).

- Research question: stated as briefly as possible.

How does technological innovations
shifting impact the world
of filmmaking.

ANNOTATION

- Argument/contribution: two to three short bullet points, briefly describing the authors' answer to the central research question and its implications for research, theory, and practice.

- Key findings: three or four short bullet points identifying key patterns in the data that support the authors central argument.

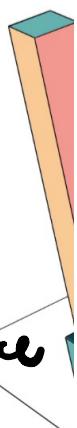
- Unanswered questions: two to three short bullet points that identify key limitations of the research and/or questions that research did not answer that could be answered in future research.

- Relevance of work: how relevant is it to your research and in what perspective.

- relevant to show how directors
use tech through their perspective

. used data based on
Ang Lee films,
efficacy in showing
how tech in film
would advances .

-Also shows Lee's
resist of old techniques
in film tech that further
strengthens his films.



Session 2

“SIGNIFICANCE OF SOUND IN FILMMAKING AND CHALLENGES FACED BY PAKISTANIS”

FAHAM UDDIN HAQQI

[ProQuest document link](#)

ABSTRACT (ENGLISH)

ABSTRACT

This research article investigates the significance of sound in the filmmaking process and the specific challenges faced by the Pakistani film industry in this domain. Commencing with an examination of Pakistan's music industry, notably exemplified by projects such as Coke Studio, the study elucidates the historical trajectory of sound within cinematic contexts, tracing its origins from Thomas Edison's Phonograph to the pre-partition era of cinema in Lahore. Despite the nation's rich musical heritage, the research underscores the impediments encountered by Pakistani filmmakers concerning sound recording, mixing, and studio infrastructure development. Employing qualitative research methodologies, the study conducts an in-depth analysis of the present state of sound production in Pakistani cinema, facilitated by interviews with industry experts.

It elucidates the transition towards internalized sound mixing processes while highlighting enduring challenges, including the scarcity of adequate sound studios, reliance on antiquated equipment, and financial constraints. Moreover, the research delves into technological complexities, software utilization, and sound mixing techniques within the industry's current landscape. In conclusion, the study advocates for enhancements in sound production infrastructure, alongside investments in modern technologies and educational opportunities for sound producers. Emphasizing the necessity of addressing these challenges and prioritizing sound quality in filmmaking endeavors, the research posits that such measures can significantly augment the cinematic experience in Pakistan. By offering a comprehensive analysis of this often-overlooked facet of filmmaking, the study furnishes valuable insights conducive to the future advancement of the Pakistani film industry.

FULL TEXT

INTRODUCTION:

In the contemporary scenario, **Pakistani music industry is doing wonders in form of multitude of music projects** (Arshad, 2018). **Coke Studio has been a major hit in this era of technological advancement**. Musicians all across Pakistan, have gathered on the platform of Coke studio and are presenting a diverse range of songs. However, the sounds in the film industry are still in its growth phase and experiencing sound management and studio development challenges.

Newer history

Reviewing the history of cinema development original sound recording and management, it has been found that **Thomas Edison is recognized as the founder of cinema, with his early film Fred Ott's Sneeze that was launched in 1894** (Gunning, 1989). He was the inventor of Phonograph, in 1877, which is the first sound recording device. Dickson, on the other hand, assisted Thomson, in synchronizing sound and film, but experienced failure. In the pre-partition era, Dialsukh M. Pancholi, was recognized as a popular Hollywood movie distributor. **Pancholi Art Picsstudio was initially developed by him in Lahore and was recognized as Pancholi Film Co** (Siddique 2017). **This studio produced mega hit Punjabi movies; Yamla Jatt (1940), Gul Bakavli (1939) and the Khazanchi (1941)**, which is an incredible Urdu/Hindi musical film. All the film studio's in Lahore, were destroyed due to political upheavals of that era. Pancholi rebuilt his studio on the Upper Mall Road of Lahore during February, 1948 (Pakistan Film Magazine, 2018). Later on, Deewan Sardari Lal, an assistant of Pancholi, launched the first Pakistani film; “Teri Yaad” (1948). Malika Pukhraj, famous Pakistani singer, took the charge of Pancholi studios, and named it as Malika

Outline of Film world Non-diegetic (diegetic) — Sound from in film world

Studio. After sometime, Malika Pukhraj sold the studio which was then recognized as Jawidan Studio. Since then, Pakistani film industry has experienced many ups and downs (Dudrah, 2002; Kirk, 2016; Yousaf, Adnan, and Aksar, 2017). It is after 1965, that the Pakistani actors started to present their films across the borders.

Notably, the film that was produced in Pakistan, was Shahida, featured Dilip Kumar's brother, Nasir khan. Likewise, after decades of film industry development, Muhammad Ali, a Pakistani actor, got featured as a clerk of Manoj Kumar, an Indian actor. Mohsin Khan, Qatil Shifai, Nusrat Fateh Ali Khan, Haseena Moin are big names of Pakistani film industry, they were welcomed by the Bollywood, 1980 onwards. Pakistani singers as Rahat Fateh Ali Khan and Atif Aslam are recognized as renowned performers in Bollywood. In 2019, there are 4633 artists working, 977 cinemas and approximately 9266 film songs produced (Pakistani Film Magazine, 2018). A number of Cinema's exist in Karachi; Capri, Nishat, Prince, Atrium, etc, with Capri cinema having 850 seating capacity and 7.1 Dolby sound system.

How Sound plays into Film

The term "sound" in the discipline of film making refers to the music, sound effects and words (Costanzo, 2017; Wilkins, 2016). Sound play a significant role in a movie. For instance, it helps in enhancing the plot, elevating the mood, serves as an explanation of film characters, provides relevant information regarding scene location, etc (Candusso, 2015; Wierzbicki, 2012). Empirically, sound can be classified as, Non-diegetic and Diegetic. In Diegetic sound, the sounds as door slamming, dialogue, and footsteps, etc. can be added. These audio facets come from sources that exist within the film world. However, the non-diegetic sound is inclusive of a source that comes from outside the film functional world (Savukova, 2010). For instance; the sound effects of screeches in shower scene recorded in film "Psycho".

Some of the filmmakers exhaust the sound to amplify the meaning or emotion in a movie scene. The character's threatening feature is reinforced in front of the audience. These exaggerated sounds are known as Pleonastic sounds.

These sound effects add flavors to the ecosphere or mood of the film, via the generation of a soundscape (Conde, 2017). These further, enhance the meaning of visuals that appear during the scene. Filmmakers alter the tempo, volume and pitch of these sounds, on the basis of his expectations from the audience, to respond to the noise in a certain manner (Mott, 2014; Tan, Pfördresher, and Harre, 2017). For example, in the horror movies, squealing tires or screams are high-pitched sounds, that create a sense of anxiety among the audience. On the contrary, a sense of calmness or mystery can be generated via low-pitched sounds. For instance, the swinging of a door, bird's voice, and sound of waves, etc. Nevertheless, the most captivating use of sound in a movie scene, is the absence of sound i.e., silence. Silence is often generated to augment a scene's intensity or to create suspense for an imminent doom. In the contemporary film industry, sound effects as phase blasts, animal and wind sounds are added to enhance the film experience (Wilkins, 2016). In the contemporary scenario, surround sound has been integrated to the film industry as a "directional" facet (Sheehan, 2018). For instance, the addition of echoes, a type of surround sound, gives an impression of three-dimensional sense of movie space. Another category of sound is known as unmotivated sound. These sound effects, has no logical connection with the scene, although they elevate and enhance emotional influence of the movie scene.

Methodology

A qualitative research methodology has been adopted in this research. The film producers and singers have been interviewed and analysis has been presented. Convenient sampling strategy has been adopted and as per the convenience the selected film producers and singers have been interviewed.

Analysis Previous developments Specific to Pakistan

A productive change can be seen in the Pakistani film industry. The sound mixing is now performed in Pakistan, but previously, people had to go to international locations as America, to record their sound and go through the procedure of sound mixing. Kashif Ejaz is working with the Pakistani film industry. He remained engaged for sound mixing etc, in Actor in Law, Namaloom Afraad, Teefa in Trouble, movies sound mixing. The sound effects in the aforementioned movies are of a high standard, and can be heard through the microphones. There are two types of sound mixing; mono channel and stereo channel.

The contemporary music directors in Pakistan works on Keyboard, however, the actual feel comes from real equipment's as Tabla and Violin. These instruments on the key board give fake music impacts. During interviews with Shuja Haider, Faizi and Ahmed Jahanzaib, it was found that these singers are mature, but still they rely on the keyboard. On the contrary, the singers like Bilal Maqsood, Shahi (Vital Sign) and Imran Kazim, as remarkable Music Directors mentioned that Orchrushna is the best tool that must be integrated.

However, during the interviews the biggest challenge faced by the film industry has been recognized. In Pakistan, there are limited number of sound studios; Radio Pakistan, Coke Studio, Pakistan Television Studio. There is no studio to record private production in Pakistan. Previously developed studio namely; Greece was initially a warehouse of Pepsi. This studio is not sound proof, and has mikes that are over sensitive. The singers mentioned that for Mehdi Hasan, a special mike was developed due to his low pitch. He was a remarkable semi-classical singer and a special mike was developed for him. Arguably, in Pakistan, singers like Shuja Haider and Ahmed Jahanzaib, are recognized as better singers than the Indian/Asian ones. It is obvious by the fact, with Pakistani singers outperform are in Indian events and conduct live concerts.

Mene chehre yeas

They outperform the Indian singers. Another challenge faced by the sound industry, is that the young Pakistani singers are not valued. They perform at small level, and paid less than they actually deserved for. There is huge talent in Pakistan and the Pakistan singers are experts in playing guitar, keyboard playing.

One of the interviewee highlighted that there are different types of music directors; tuner/composer and arranger. In Audio Dialogue Replacement (ADR), the dialogues are recorded first, and then during the shoot, the actors are asked to say those dialogues exactly in the same manner. Across, the globe, the sound in a movie is recorded between 5.1 or 7.1, Dolby surround sound and then it is converted into Digital Cinema Package (DCP) format so that it could be played in the Cinema. Unfortunately, Pakistani film industry is unable to record the sounds in between 5.1 or 7.1 Dolby. Rafiq Ghaznavi introduced the concept of Background Music Score (BGM). Sound mixing takes place via a number of steps. The Film Producers and Directors, working since 2000, in Pakistan, still rely on the Automatic Dialogue Replacement. The challenge is that Pakistan does not have the needed equipment.

Nabeel Qureshi and Jalal, producer and director in Pakistani film industry, prefer location sound recording. In this the visual sound is recorded with the help of a third person, who holds mike. The mike cost is high that is between 4 to 5 lacks, and if the mike is being used, then there is no need to use ADR. Jack Foley, was the inventor of Foley sound, that is deemed as live action sound, which is generated at the studio, by means of routinely surfaces and objects (Wierzbicki, Platte, Smith, Beck, Ament, and Kerins, 2015; Reddell, 2018). The Foley effects are recorded by the Foley artists in the editing stage, with moving image, used for guidance. Apart from Foley, another sound effect is known as ambient sound (Owens, Wu, McDermott, Freeman, and Torralba, 2016), which is unique in context. Ambient sound is effective in recording blips in sound, in the form of a "patch". Mikes that are available are of different types; uni-direction, bi-direction and omni-direction.

The uni-direction mike is available in the form of hand and collar mike. Bi-direction mike has two sensors, and usually used in the FM studios and radio stations. The omni mike on the contrary, is a boom type multi-purpose mike usually known as folly. Music scores are prevailingly used by filmmakers as a tool to create an emotional response in the audience. Filmmaker's are tremendously using these scores and let the audience react differently to different scenes. Music is often used as an opening gambit for a movie, while played at the backdrop. John William composed a brassy theme music, which gained massive popularity and has been parodied by many. Music score has been integrated by the horror movie filmmakers and is responsible to generate suspense and tension, exactly before the monster had to attack.

Concussively, music is used as a powerful tool in the representation of cultural or ethnic context. In the documentary films, there is a common practice of integrating voiceovers. One example is the Original Blade Runner film launched in 1982.

As the ADR is deemed highly expensive, therefore, due to unavailability of this equipment, only general sound is being recorded. The LSR records only mono-channel sounds, and then these sounds are them edited copy and pasted so that they can be used as stereo sound, which is 5.1 Dolby or 7.1 Dolby. Evidence has shown that

technology is impacting the film industry with a rapid pace (Adrian, 2017). According to Adrian (2017), in the past decade, the cinema operator used to invest on a 35mm projector, which was having xenon bulbs or 7.1 and 5.1 sound.

However, the challenges for the film directors are increasing. They are facing difficulty in understanding monetizing and operational management of sound options. This challenge is faced across the globe. Unfortunately, Pakistani film producers and directors are unable to manage the 5.1 Dolby or 7.1 Dolby yet. Only a couple of Pakistani music directors have managed to record their films internationally with the aforementioned Dolby formats. Additionally, there is a scarcity of financial budget in the Pakistani film budget. The filmmakers that have received higher education from international locations in the filmmaking are the only ones struggling to have films with high quality. After becoming successful in few of their films, they have now managed to develop their films in the 7.1 Dolby formats. However, in Pakistan, there is a significant crises in the development of sound studios, that could serve as a platform for new upcoming film sound producers and developers.

Conclusion

Review of literature in the Pakistani music and cinema industry reveals a severe scarcity of sound research. There are challenges faced by the music directors and film directors in recording of the sounds and converting them into cinema sound formats, however, the literature does not highlight this. The information is available through media and YouTube channels; and there is a need to highlight the challenges faced by the Pakistani filmmakers in recording of sound.

Suggestions

The paper has discussed the challenges related to the sound in the filmmaking faced by Pakistanis. This section presents suggestions for improvement of the sound in the Pakistani film industry. The interviews revealed that the Pakistani film industry is unable to manage the software issues. There is a shortage of equipment's for sound mixing. The music producers are affected largely. They have software issues. The folly sound is not taken seriously. There are technology and financial challenges. The sound studies are not completely equipped with latest sound mixing software. The music producers go abroad and then mix the sound, to be played in their movies. There are challenges associated at the Racket level. A high usage of plugin sound is evidenced in contrast to the 5.1 or 7.1 Dolby sound. The lacking of software enforces the music producers to use the crack versions, which are again a challenge.

In these scenarios, it is high time for the sound and music in the Pakistani film industry. There is a need to assign budget for the music and sound related issues. There is a need to invest in the latest technology and sound mixing software's so that a good quality sound can be produced in Pakistani films. The international training of the film sound producers may be a good option. However, this require the transmittance of that knowledge amongst other film sound developers so that they could take maximum advantage from the international trainings and improve the sound mixing quality.

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DETAILS

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Some talks about problem of access to technology how a lot of people in the int'l sense do not have the facilities to keep up especially in countries w/ smaller entertainment industries like pakistan.

Makes the argument that Pakistan faces many issues getting access to updated technologies despite the early success of the industry

ANNOTATION

- **Citation:** in couple of chosen styles (IEEE, ACM, others)
- **Key background:** two to three bullet points identifying the theory/prior research on which the authors are building and defining terms.
- **Data/ methods:** one or two short bullet points with information about the source of the data and the method of analysis, with a note if this is novel or particularly effective example of that method.
- **Research question:** stated as briefly as possible.

9

ANNOTATION

- **Argument/contribution:** two to three short bullet points, briefly describing the authors' answer to the central research question and its implications for research, theory, and practice.
- **Key findings:** three or four short bullet points identifying key patterns in the data that support the authors central argument.
- **Unanswered questions:** two to three short bullet points that identify key limitations of the research and/or questions that research did not answer that could be answered in future research.
- **Relevance of work:** how relevant is it to your research and in what perspective.

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VPET – A Toolset for Collaborative Virtual Filmmaking

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Animationsinstitut, Filmakademie Baden-Wuerttemberg

innovations not
nearly available

Abstract

Over the last decades the process of filmmaking has been subject to constant virtualization. Empty green screen stages leave the entire on-set crew clueless as real props are often replaced with virtual elements in later stages of production. With the development of virtual production workflows, solutions that enable the decision-makers to explore the virtually augmented reality have been introduced. However, current environments are either proprietary or lack usability, particularly when used by filmmakers without a specialized knowledge of computer graphics and 3D software.

As part of the EU funded project *Dreamspace*, we have developed VPET (Virtual Production Editing Tool), a holistic approach for established film pipelines that allow on-set light, asset and animation editing via an intuitive interface. VPET is a tablet-based on-set editing application that works within a real-time virtual production environment. It is designed to run on mobile and head mounted devices (HMD), and communicates through a network interface with Digital Content Creation (DCC) tools and other VPET clients. The tool also provides functionality to interact with digital assets during a film production and synchronises changes within the film pipeline.

This work represents a novel approach to interact collaboratively with film assets in real-time by maintaining fundamental parts of production pipelines. Our vision is to establish an on-set situation comparable to the early days of filmmaking where all creative decisions were made directly on set. Additionally, this will contribute to the democratisation of virtual production.

Keywords: virtual production, filmmaking, on-set editing, collaborative work, production pipeline

Concepts: • Computing methodologies~Rendering • Software and its engineering~Virtual worlds software • Software and its engineering~Real-time systems software

1 Related Work

In 2012, the visual effects company Zoic Studios published the tablet application *ZEUS:Scout*. It provided a physically correct view into the virtual world and enabled the user to perform modifications in the scene by tapping on the multi-touch screen.

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Another real-time tool called *RTFX* [Northam et.al. 11] constituted a more generic framework. While most of the existing toolsets were designed to perform only one particular task, like editing or rendering, the *RTFX* application built up a client-server architecture to address any DCC tool or game engine. Those solutions were optimized merely for previsualization and thus could not meet the demands of real on-set virtual productions. ILM's *xLAB* is currently developing a variety of on-set tools for scene viewing and manipulation in virtual production and mixed reality. Most recent work combines a tablet with a virtual reality controller for positional tracking [Wooley 16]. Unfortunately none of these developments are available publicly. It is also unclear how much impact those demonstrated tools had on the actual production process.

Another example is the short film project *Adam* [Efremov 16], which was realized using game engine technology. While this is visually a very convincing demonstration, it does not show how real-time technology enhances the creative filmmaking process in a collaborative manner. *Adam* is also constraint to the use of one specific technology including its asset creation pipeline.

The main difference of our approach, in comparison to the above mentioned examples, is that it can be applied to any central production system. A previous prototype within our project *Dreamspace* combined a gesture-recognition controller and a HMD tracked via a motion capture system (Figure 1). The user was able to access all three axes simultaneously while being able to examine the virtual world in a most immersive manner. This approach and its use cases already introduced some promising advancements in the fields of asset modification and pipeline integration. However, concluding surveys on the gesture-recognition approach for example revealed that untrained personnel were barely capable of performing even basic transform tasks like selecting or positioning an object in space [Trottnow et al. 15]. The HMD proved to be a potential solution at first, but it seemed inappropriate for on-set productions as long as gesture-based input devices lack usability.

To solve the gesture recognition problem VPET builds on a user-friendly tablet interface, allowing production and post-production tasks to happen in one logical (data) space where different technologies can be combined. VPET also provides an architecture for using various real-time input and output devices.

2 VPET – A Holistic Approach to Established Offline Pipelines

Various virtual production pipelines have been built around game engine technology, taking advantage of the development capabilities they offer. While this certainly makes sense, it also means a tremendous effort to adapt existing offline pipelines and established tool chains. In this sense, the main novelty of VPET is that it constitutes a generic, real-time, and open framework that can be integrated into any existing workflow.

Set to
make
new
accessible



Figure 1: Evaluation of early prototype.

As a user-friendly alternative, our tool supports trained talent, and also those without exhaustive experience (like the director or other set staff), who being subject to completely new authoring processes might slow down the production. This opens the possibilities to use VPET not only in highly budgeted productions, but also in more amateur ones that do not count with professional staff, leading to the democratisation of virtual production methodologies. Moreover, it allows the people involved in the production to communicate ideas quickly and visually, making the whole process more efficient and effective.

As a collaborative tool, VPET has been built to enable real-time editing of streamed virtual scenes, and can be used with Katana, our own software prototype called LiveView, or any other similar software alike. VPET can also be adapted to any central production software that supports the necessary functions for accessing scene data, allowing VPET to be used in a wide variety of production scenarios. This would require writing a dedicated *scene distribution plugin*.

LiveView combines technology from The Foundry's products *Katana* and *Nuke*. LiveView also includes implementations from several research partners on novel light capture and compiler technology for real-time ray tracing [Lei  a et al. 15].

3 VPET - Overview

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VPET is an application for tablets running Android, Windows or iOS and has been developed based on the *Unity* engine to explore possibilities for collaborative on-set editing of virtual content. Users can grab a tablet at the film set and start exploring and editing the virtual content, performing simple edit tasks of the virtual elements of the shot in a fast and intuitive way directly on set (Figure 2, left).



Figure 2: Director using VPET (left). User Interface (right).

3.1 Supported Features

3.1.1 Virtual Camera

VPET synchronizes the virtual camera with the real production camera by streaming tracking data to the tablets. Thereby it is possible to see the virtual elements of the scene on the tablets from the perspective of the principal production camera.

Changing the position of the virtual camera in the scene is possible with multi touch gestures. By rotating the tablet the virtual view is rotated as well. Latest hardware such as Google *Project Tango* can be used to track the position of the tablet allowing the user to explore the scene interactively. Professional camera tracking equipment like *ncam* is also supported.

3.1.2 Object Editing

An intuitive interface reflects the potential and complexity of the underlying architecture. It enables anyone to edit position, rotation and scale of objects present in the streamed scene as well as parameters of the virtual lights.

To further enhance the user experience, alternative interaction approaches uncommon in typical DCC applications have been developed. For instance, scene objects can be either carried around in the scene by attaching them to the tablet's viewport or repositioned by simply tapping on the ground. Additionally, an orthographic top-down view is provided to offer a better scene overview and organisation.

3.1.3 Animation

The user is able to create and modify keyframe based animations on scene objects. Those animations are then playable on a global timeline which is synchronized between all participating clients. Animation queuing allows to author a specific animation and trigger it on demand. This feature was implemented upon request from one of our project partners, as it was a functionality they were missing in established virtual production tools.

3.2 Graphical User Interface

The user interface builds on icons and navigation principles common in state-of-the-art applications [Bowman 05]. Menus and buttons are designed for a two-handed tablet resting position and occupy as little screen space as possible. A context-dependent circular menu encompasses the most important functionality for asset transformation and animation editing while less frequently used features remain hidden in a menu accessible through a button in the upper right corner (Figure 2, right).

3.3 Architecture and Integration

The architecture of the proposed system is based on the three main components: *scene distribution plugin*, *synchronization server* and *VPET application* (Figure 3).

3.3.1 Scene Distribution

Upon initial start-up of VPET the *scene distribution plugin* streams the scene-relevant data to the clients. This is an essential novelty in terms of pipelining and data preparation. Once the

VPET Provides Solutions to Riddlekey in the Collaborative Local Space

scenes are prepared using Katana, an established software for look development, lighting and shading, no complicated setup process is needed to transfer load and configure a client.

A scene that is intended to be used in a VPET real-time environment must contain relatively lightweight versions of assets in terms of textures and polygonal count. These low-res versions are streamed to the mobile client instead of the full geometries. To achieve this, additional steps have to be performed to provide real-time optimized assets. This has proven to be a time consuming task and could be improved by directly implementing an automated process during export.

Compared to current approaches, where all production data needs to be shifted to a game engine, our solution presents the advantage of allowing a selection of an asset subset that are editable in real-time with reduced overhead cost. Furthermore, it gives the opportunity to return to the final offline production process afterwards.

Producing applications to fit in

This is a general approach and needs to be implemented through the plug-in interface at the main application. The plug-in identifies assets to be streamed and converts the meshes, the textures and the scene topology in a format handled by the Unity 3D Engine without further processing on the tablet side. To overcome the boundaries of different data representation between the C++ server plugin and the C# client, an additional reinterpretation of the streamed data is realized. Every incoming data block is split into chunks, which are then interpreted as scene, mesh or texture data.

All changes performed during the production are recorded and can be fed back to the production pipeline, in our case LiveView, where further postproduction steps are carried out. Objects that shall later be edited via VPET receive a special attribute.

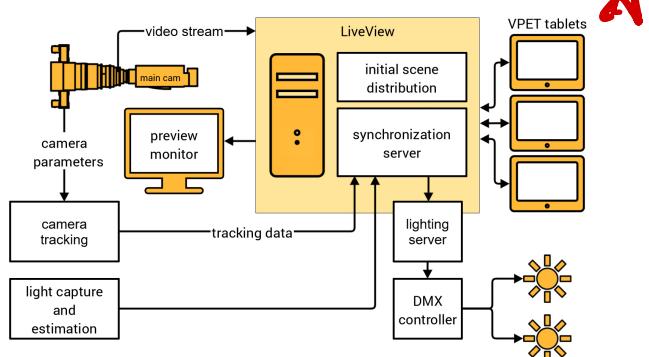


Figure 3: Schematic view of the production setup.

3.3.2 Scene Synchronisation

Multiple tablets running the VPET application can be used in parallel to explore and edit the virtual scene simultaneously. All changes made to the scene on one VPET tablet are immediately sent to the synchronization server, which then communicates those changes to all other attached clients (tablets, LiveView or Katana). In this sense, it works as a fan-out server for all incoming messages. All communication is implemented through the ZeroMQ distributed messaging library. A publish-and-subscribe pattern is used to provide the possibility to only send the relevant messages for each individually configured message-receiving client.

The synchronization server also provides an interface to receive real-time camera tracking data. The camera data is transferred to every subscribed client and can be used to simulate the main camera in the virtual scenery.

Thanks to the communication through network sockets, VPET can be connected to any application that provides a formatted scene description and accepts messages carrying parameter updates.

Currently a direct interface to LiveView/Katana exists, and it is capable of streaming assets to the clients, as well as receiving changes made by VPET. It prepares and holds the asset data and sends a binary package to a client on request. A real-time scene holding 180k vertices and 10MB textures requires about 10 seconds for transfer and recreation on the device. LiveView/Katana listens on a second port for incoming parameter updates and immediately applies them.

Synchronisation of animated content turned out to be a major challenge because animations are authored on the individual client tablets, which run at arbitrary frame rates. As such, the broadcast of updates to LiveView and other clients can produce undesired artefacts in the recorded data. A possible solution is to interpolate the animation data based on a global time code.

4 Light Capture and Harmonisation

Another branch of the project focused on novel light capture with particular scope on estimating the position, falloff and cone angle of multiple light sources on a set [Einabadi and Grau 2015]. This information is used to harmonise real and virtual lights for better integration of computer generated content. A set survey is performed to estimate the light situation. This process takes about 15 minutes. The results are fed into the LiveView system where they can be distributed to the VPET clients. Light parameters like intensity and colour can now be edited using the tablet. In return, the real light parameters are updated via a DMX controller interface, for instance, when using LED panels. One big challenge was the varying interpretations of light parameters across offline render and real-time engines, resulting in scenes that appeared too dark or too bright.

5 Production Evaluation

VPET has been evaluated by experts and novices alike in various productions along different stages of development (Figure 4). A practical use case of our project developments was the documentary film *Skywriters*. The director used VPET for fine-tuning position and animation of CG planes while constantly reviewing the composited output. The *Skywriters* crew highlighted the image quality of the Live View render as surprisingly good in comparison with other available solutions. In general, the VPET setup convinced the team of the feasibility of having a virtual production as an interactive and collaborative workspace.

Another positive experience was undergone during the public at the FMX2016, where an evaluation questionnaire was conducted among a group of experts. 80% confirmed an advance to the current state-of-the-art tools, 10% did not agree, and the remaining 10% left a clear open answer. Performance of the system was rated on a scale from 1 (poor) to 5 (highly efficient). 50% rated with a 3 and another 50% with a 4, meaning that the

system performed quite efficiently. 70% agreed that this technology could change and improve the preproduction process, 10% negated it, and 20% were undecided. When asked if the technology could improve onset and post-production processes and in general enhance creativity, 90% agreed, while 10% did not share this point of view.

A final evaluation was carried out during a five day co-production of a pilot for a new TV series format. The partner was *Stargate*, a commercial company with branches worldwide and major expertise in virtual production. While evaluation was not solely focused on VPET, the feedback on this particular aspect was very positive. The VPET tools were intentionally used for light, set and animation editing. On the last day of this production VFX and animation companies of the region Stuttgart (*AMCRS*) were invited to get to know the technologies and perform an expert user evaluation. The results of this evaluation pointed out that the proposed system offers an intuitive solution to interact with the digital elements of a virtual production, maintaining at the same time flexibility on the central production system.

In general the feedback was positive in terms of usability and ease of access. One of the elements that underwent multiple redesigns based on output of the evaluation process was the graphical user interface. Also, setup times between scenes and preparation of content is a point for future improvement.

Among the most relevant features requested by the expert user group were improvements regarding the viewport navigation and extended features for virtual scouting (e.g. lens simulation). Future developments could address complex character animation capabilities and a constant mapping of light parameters across the entire production system.

Within our project another major strand researches immersive experiences and its application in performing arts through a series of artistic installations. VPET was also successfully used in such environments.

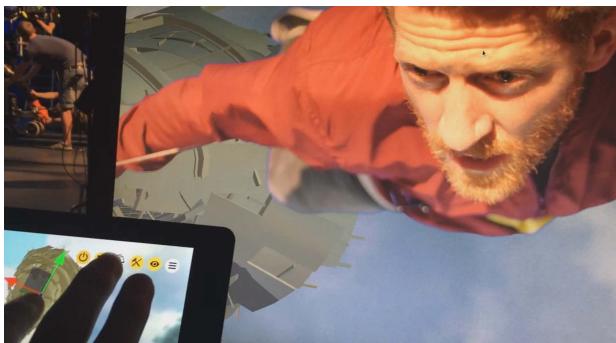


Figure 4: Evaluation during Filmakademie production, actor in flight rig in front of back projection, VPET controlling debris.

6 Democratisation of Virtual Production

The majority of the existent virtual production pipelines are proprietary and mostly apply for large scale productions with big budgets. Through the holistic approach of VPET it is now feasible to realize virtual production-like scenarios at much lower costs and efforts. For instance, Katana is used to define the look of a shot. By using VPET, a collaborative session could be established where all creative team members can interactively edit the content

of this specific scene. An offline renderer connected to the system reflects these updates and provide high quality results. This will ideally lead to the establishment of new production processes that will enormously enhance creativity by creating a truly collaborative environment with reduced post-production cycles.

VPET is released under an open-source license to share the tools with a wider user group and to take advantage of collaboration with the community. This aims at distributing the editing tools to a wider audience and developing new plug-ins for different applications.

Acknowledgements

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Really good at explaining how VPET has
the potential to improve the R&M industry
industry through a collaborative post
production/animation environment.

Post-Production of Digital Film and Television with Development of Virtual Reality Image Technology- Advance Research Analysis

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Abstract - Background: Virtual reality (VR) has steadily become a hot topic in society in recent years. VR virtual reality, as a medium combining computer technology, imaging technology, and human-computer interaction technology, offers both a new interactive narrative approach in the evolution of media and a new way of communication in the text-change era. Post-production is an important part of the filmmaking process. To ensure the quality of film and television works, it integrates pre-production and boosts job efficiency. Before using computer production software to complete the editing and processing of the film, film and television post-production must wait for the film and television production to be completed.

Purpose: The purpose of this article is to investigate the current state of VR reality application post-production of digital cinema and television, as well as the status of virtual reality in film and television post-production, to assist film and television post-production.

Methodology: A quantitative and qualitative method has been used as were questionnaire survey and a random selection of 50 students interviewed for digital image synthesis majors who have worked in digital cinema and television special effects production are used to assemble and assess the survey results in this study. The SPSS quantifiable programming is also used for preliminary research, such as determining predictability, consistent quality, and legitimacy.

Conclusion: The VR technology improves the programme by adding colour to the work. The use of virtual reality technology in late-stage film and television production has aided the development of diverse creative as well as film and television post-production.

Recommendation: Further study should be done simultaneously, the use of VR virtual reality technology has increased film and television production efficiency, cut physical set costs.

Index Terms - Post-Production, Virtual Reality, Digital Film, Television, Art

1. Background of the study

INTRODUCTION Explanation of post production filmmaking

The basic goal of cinema post-production is to combine many shots into a full film by processing the various elements that have been shot utilising specialised technology. The post-production stage of the filmmaking process is crucial. To guarantee the nature of film and TV works, it coordinates pre-production and lifts work proficiency. Before utilizing PC creation programming to finish the altering and handling of the film, film and TV after creation should hang tight for the film and TV creation to be finished. In film and TV, after creation is an extremely elaborate connection that includes various creative processes. To convey a completed film or TV work, use film and TV after creation to add a couple of enhancements, as well as alter and sort out recently delivered video pieces. The three main steps of post-production in film and television can be classified into three groups (Vertemati et al., 2019).

The most essential stage in the after most-production of film and TV works is focal point modification or focal point altering. Cutting and sorting out the various shots in the film and TV works so the focal points in the film and TV works have a harsh plan is this piece of the gig. Getting ordinary cuts of film and TV creations and afterwards reworking them, gathering shots with no focal thought or request into coherent, deliberate, and coordinated Storytelling material with the assistance of filmmakers. There are many different forms of editing, and not all of them are covered here. The director's ideas have a direct impact on the film's positive and negative aspects. and television work, as well as the editor's abilities, are all crucial (Chen & Yang, 2020).

Moreover, editing audio film and television productions rely heavily on sound. While the lens is being edited, sound, such as the soundtrack and dubbing, should be treated in post-production. There are two sorts of dubbing procedures available right now. To ensure that the dubbing is comprehensive and synced with the story picture and work growth, record the sound concurrently. When editing the sound afterwards, the edited sound should match the edited picture. Then there's the post-production phase. This form of dubbing does not require a great deal of technical expertise. The lens is usually cut first, followed by dubbing by the dubbing crew. Only the volume needs to be modified at a later time. A superb film or television show's soundtrack is frequently more remembered than the film or television show itself. It must be integrated with the story's theme to establish the play's atmosphere, and it will aid in the creation of a situation (Huang et al., 2018).

Special Effects Impact

1.1. Synthesis of special influences

The creation of special effects is an important environment in film post-production. Special effects have a long and illustrious history. A commonly utilised film and television production technology are gradually developing towards high-end. Advanced special effects technology must be used during the production process to obtain the desired creative impression, hence 3D technology is becoming more widespread. In a range of cinema and television productions, 3D technology is now frequently utilised. A three-layered virtual climate produced with PC innovation is known as augmented reality (VR). This innovation can transform two-layered films and liveliness into three-layered ones, offering clients a more vivid encounter and giving the crowd a superior review insight.

In addition, this article assesses what is going on and the problem of computerized film and TV after its creation with the advancement of augmented reality picture innovation by directing a poll study and arbitrarily choosing 50 undergraduates for advanced movie combination majors who have taken part in advanced movie embellishments at a university. The use of virtual reality (VR) in film and television post-production has resulted in the film and television industries diversifying their work, promoting the development of film and television post-production, and raising the overall level of post-production, according to the findings. Simultaneously, the employment of virtual reality technology enhances film efficiency, reduces the cost of arranging real-world scenes, and saves resources. Along with technological advancements. The way the film and television industries operate has changed dramatically. The use of photography equipment and the use of hypostatic tools for editing have both become obsolete. The film and television industries are increasingly dominated by computer graphics. China is developing digital film effect studios, which are primarily supported by computer graphic technology, as well as virtual reality photographing systems. And they're accelerating the growth of film and television production. The status has a significant impact on the improvement of hardware conditions (Li et al., 2017).

PROBLEM STATEMENT

In China. With advancements in digital software technologies. The state of cinema and television hardware is likewise evolving. The old mechanical shot has been moved to computer simulation, and computer simulation is evolving into integrated virtual reality technology. At present, there are still a few companies using virtual reality. But the author believed it. In the future. The direction of film and television made methods must be a combination of virtual and reality, and the application of hardware equipment and software complement each other .it will influence the development trend of the film and television industry (Zhang et al., 2020).

Virtual reality imaging technology's impact on the film and television industries As a result of virtual reality picture technology, the director's position in film and television is changing. This is because all those who have nothing to do with the performance, such as the videographer, are unable to be there during the virtual reality image production process. Unless the director is the same, they will wear it. As a result, the director can only express his or her opinions in the spaces between recordings, or re-shoot in the form of cards, as in the case of sports coaches. The director's role is similar to that of a drama director in several ways. Among other things, he may create and dress in costumes, music, walks, props, lighting, and performances. Using virtual reality picture technology, changes in storey structure, roles, and views in cinema and television works can be made. The impact of virtual reality picture technology on the film industry's selection of tales and film scripts is shown in the views, roles, and plot modifications in movies based on virtual reality image technology. Traditional film and television works differ greatly in terms of plot structure, narrative viewpoints, and tale characters. The full-angle film is a virtual reality image technology film. The audience's eyes are represented by the middle axis (Radianti et al., 2020).

To overcome this issue there need for post-production of digital film and television for the development of current VR image technology for better performance.

RESEARCH OBJECTIVE

1. To determine the importance of using virtual reality images in film effect production.
2. To examine the proportion of virtual reality technology in film and television production.
3. To evaluate the existing virtual reality image studio as the research object to predict the future development trend.



RESEARCH QUESTIONS

1. What is the importance of using virtual reality images in film to affect production?
2. What is the proportion of virtual reality technology in film and television production?
3. What is the available existing virtual reality image studio as the research object to predict the future development trend?



LITERATURE REVIEW

This section offers a review of the literature on the study's main topic. This literature review can help you gain a better knowledge of the subject as well as the study's goal. This article gives an overview of digital film and television post-production, as well as the development of virtual reality image technology in several fields, including the building sector. Perceptual, Virtual Reality Technology and Film Art also research the Prospects for VR Virtual Technology Application in Film and Television Art and defined and scope of virtual reality technology. In addition, we will look at the current state of virtual reality technology in this area. At the end of this review, mentioned the role of virtual reality technology in image visualization and film and television post-production

I. 5.1. Framework for Research Problem

1. Be used as a digital camera shooting instrument and real-time transmission in film and television production.
2. Be used of film aftereffects edit and palette in teaching the film and television production.
3. Be used to digital virtual reality and visual preview in film and television production.

II. 5.2. Perceptual

Another crucial feature of virtual reality technology in film and television productions is **perceptual**. The information flow between the technological equipment and the audience is dynamic when an audience interacts with virtual reality technology and the audience's perception in real-time. As a result, for the spectator to have a more authentic sensory experience, the screen displayed by the linked art equipment must be extremely consistent with the viewer. Augmented reality innovation might change a customary film into the present status of the screen, permitting the picture to emulate the crowd's development and proposition an alternate and practical picture as the crowd's development mode changes. Virtual reality innovation has been generally utilized in the realm of gaming because of this component, and individuals wear exceptional hardware to get a more practical game insight. There is as yet quite far to go in film and TV creation because of worth issues and specialized troubles, however, this could turn into a pattern in the field of film and TV over the long time (Lei & Kim, 2021).

Virtual Reality Technology and Film Art How they connect:

Film and television art is an independent segment composed of a single lens, followed by a complete storey constructed by multiple independent segments, and virtual reality technology was widely used in the game field in the early stages of development, relying on post-modelling software to construct a virtual game situation, and virtual reality technology was widely used in the game field in the early stages of development, relying on post-modelling software to construct a virtual game situation, and virtual reality technology was widely used in the game field in the early stages of development. Although both games and movies give amusement, the art of cinema and television places a greater focus on shooting than gaming. Exceptionally vivid scene development and shooting approaches are the establishments for making film workmanship. For movie and TV works made with Virtual reality innovation, top calibre and superior execution proficient photography gear, like 360-degree cameras, three-layered cameras, light field cameras, and movement catch frameworks that can be shot in augmented experience, is expected every which way (Bao, 2022).

Furthermore, Viewers must wear a head-mounted device with similar features to 3D glasses if they wish to hear the conversation of the actors in the film or observe the fighting sequences of the characters at close range from various perspectives. These, however, Light leaking, reception latency, and viewer disorientation are all concerns with the device to some level. Film and television works of art benefit from the usage of virtual reality technology. Another key feature of virtual reality technology is "communication and interactivity," which allows viewers to freely access desired goods, choose their place, and observe in a virtual environment. In-depth descriptions of the characters in the circumstance. Subsequently, heads of augmented reality film and TV works have been scrutinized as far as how they assemble courses of action and design situations, how entertainers lead exhibitions, and how to bundle and adorn the result. Dissimilar to conventional two-layered space works, the crowd just ingests the image's feelings inactively through the tremendous screen from a remote place, not at all like normal two-layered space works. The crowd can uninhibitedly pick which scene or detail they wish to zero in on in augmented simulation movies and network shows, requiring the association of the producer. The plot, scene association, and prop plan of the work should be generally offered more consideration (Bao, 2022).

To attract the audience's attention, not only must a more condensed tale be used. Simultaneously, the work's scene props must correlate to the plot's content. To allow the audience to become completely immersed in the storey. Virtual reality films can assist performers in bridging the distance between the audience and the actors. As a result, the performers' performances must be more sophisticated. Virtual reality technology has the potential to increase the quality of film and television productions.

Prospects for VR Virtual Technology Application in Film and Television Art

Challenges of VR films

Although virtual reality (VR) has become a popular topic among the general public in recent years, this "popularity" is only for the notion. Virtual reality is not extensively used in cinema and television, and it has yet to be formally released in theatres in the United States. A virtual reality film made completely on virtual reality technology. Technology can be a double-edged sword. Virtual reality offers some benefits, but it also has some drawbacks. The duration of the film is too short, and the control is less than 20 minutes, due to device constraints. VR innovation gives watchers an expansive assortment of survey encounters; nonetheless, on the grounds, of gadget limitations, the term of the film is excessively short, and the control is under 20 minutes. As the watcher's opportunity of decision develops, the trouble of VR film creation will move. The chief will in general work on the plot setting given the circumstances. Virtual reality innovation isn't a disadvantage (Du & Yu, 2020).

III. 5.3 Definition and Scope of Virtual Reality Technology

VR vs. AR

Unlike virtual reality (VR), which immerses the user in a wholly Virtual reality environment, augmented reality (AR) aims to display information that is directly linked to the physical environment. AR goes beyond mobile computing by geographically and cognitively bridging the gap between the virtual and physical worlds. Virtual reality is the use of computer technology to create a simulated environment (VR). Virtual reality, in contrast to conventional UIs, drenches the client in an encounter. Clients are

immersed in and ready to collaborate with 3D universes rather than checking a screen out. By duplicating however many faculties as could be expected under the circumstances, including vision, hearing, contact, and even smell, the PC is changed into a watchman in this phoney world. Close genuine VR encounters are restricted exclusively by the accessibility of content and the minimal expense of handling power. Creating this link is a big objective that requires expertise from a lot of different fields of computer science, yet it can lead to misunderstandings about what AR is. For example, many people associate the visual combination of virtual and real elements with the special effects in movies such as *Jurassic Park* and *Avatar* illustration has been provided in figure 1 (Carmignani & Furht, 2011).



Figure 1. Virtual Reality Production Illustration

Technical requirements for development

High-end VR content must be developed with more technical skills and experience. Core VR development tools include:

- Design and prototyping software
- Game engines
- SDK (software development kit) of a chosen shipping platform
- WebXR Device API (for posting VR content on the web)

Publication Platform

The main destination for most VR experiences is the Steam shop, which hosts content for HTC Vive, Oculus, Valve Index, Windows Mixed Reality, and more. Most devices have dedicated shipping platforms as well. We hope that you found this overview helpful. If you're thinking that interactive high-end simulations are the right choice for you, keep reading as we will cover in detail the technicalities of developing such experiences.

Phases of Development Virtual Reality Technology

The development of virtual reality technology is no longer an undiscovered territory. We now have tools, tactics, and techniques that assist us in getting started from a lower starting position. Here, we'll go over the primary stages of developing virtual reality technology, as well as the tools and abilities you'll need (see Figure 2).



Figure 2. Basic VR Development Requirements

Sources: <https://www.altexsoft.com/>

Phases 1: Design, prototype, and 3D modelling tools

VR technology development, like other software engineering initiatives, usually begins with design. We say generally because this stage is sometimes bypassed for prototyping or educational purposes, and developers use components from community-run libraries instead.

Phases 2: Game engines

A game engine is an absolute must-have for developing interactive virtual reality technology experiences. Game and VR engines are programmes that demand programming and graphic design talents to create rich, immersive, and realistic worlds. The majority of today's popular VR engines are free (at least to a degree), readily integrated with VR platform-specific SDKs, and allow for extensive customization via APIs.

Phases 3: Platforms and SDKs

Of course, you can get into any market with cross-platform engines like Unity and Unreal, but any development requires you to choose a basic SDK to build your experience on. SDK is a plug-in that you install on your engine of choice. It includes materials, information, and approaches relevant to the engine and platform that shape the entire native experience for each device. You should start with each brand's official SDK, which is available among several community-provided APIs and tools. Phases 4 and 5 focus on advanced computer hardware and VR headsets and accessories, respectively.

IV. Role of Virtual Reality Technology in Film, in image visualization and television post-production

The transition from silent to sound, black and white to colour, and 2D to 3D may not be the only technological improvement in film. "These new "realities" are in a delicate stage of development, and they will usher in a new era of communication and enjoyment (Schütze, 2018)." It could be a greater artistic leap, similar to the transition from painting to sculpture or from photography to film. The film emerges from a two-dimensional screen's window and into three-dimensional space. VR movies lack a more mature model in terms of narrative logic and camera language, and there is still a scarcity of VR filming equipment that can match film level criteria, which is why they are unlikely to become popular shortly. Virtual Reality (VR) technology is the use of computer simulation to create a three-dimensional virtual world in which the user experiences visual, aural, tactile, and other real feelings via external interactive devices, resulting in a sense of immersion (Flavián et al., 2019).

However, in virtual reality technology cinema and television, interactivity has always been a pain point for producers, and it is now managed by assigning characters to the audience and having the show's characters converse with the viewers. Overall, virtual reality is a new medium that is motivated by the need to have an engaging experience. Virtual reality technology will usher in remarkable advances in the cinematic narrative, potentially taking it to new heights. Because of the changes brought about by the technology revolution, artificial intelligence, big data, and other factors, people are optimistic about VR. The practice of designing drawings, photos, and/or animations to express a message is known as visualisation. Visualization is becoming a more effective approach to communicating both abstract and physical information. The following are the key characteristics of VR and art design picture visualisation technology (Flavián et al., 2019).

Intuitiveness

need for quality

Man has always pushed for faster and easier access to knowledge, from the dawn of civilization to the present era of digitalization. Men in the current period are searching for tools and techniques that will allow them to operate, record, and share information more efficiently, correctly, and securely. However, the amount of data produced is increasing every day, and the need for quality is increasing as well. To meet the demand, communication intuition has been gradually increased. The way information is sent has been enriched by a variety of techniques.

Multimedia is a type of communication that combines numerous elements such as text, images, and sound. Advanced sensing technologies based on human vision, hearing, and/or touch are also used for this purpose. Furthermore, complete multimedia technologies can be leveraged to gain access to other information resources. Modern visualisation approaches, in contrast to prior visualisation methods, rely heavily on extensive media. It is not confined to a single method or media, particularly in the case of art that combines VR technology. The amount of data required to fully depict the content of the presented objects and interactions are significantly more than that required by traditional visualisation methods (He & Zhu, 2022).

Interactivity

Even if the fourth dimension of time is included, the model can still be converted into an animation that can be shown to spectators in traditional visual design. The movement of the lens is created based on the designer's ideas, not on the need to attract onlookers. The interactivity of VR technology is its most notable characteristic. That is, the author abandoned the original visual path organisation in the VR display design. The viewer is given initiative, making human-computer interaction more frequent and lifelike. People can operate as they please in this environment, ensuring that the joy of experiencing interaction is always present. The existence of value and application of VR display design may be seen in this type of information feedback between man and machine. The use of virtual reality technology in information display has opened up a new technological avenue. With the use of virtual reality (VR) in visual design, potential constraints in picture art creation can be overcome, and a more expansive and appealing expression can be realised (He & Zhu, 2022).

Authenticity

to fun w/ constraints
here is potential'

The visual design of artistic imagery utilising virtual reality technology aims to create a realistic image that can be compared to a genuine thing. It is sometimes viewed as if it were a real item, despite its authenticity and surreal aspect. It will improve the

display if the designer can use his perceptual side in the design. If the imagination is exercised further, it may resonate with the audience, fulfilling the goal of eliciting emotional responses from the audience as shown in Figure 3 (He & Zhu, 2022).



Figure 3. Authenticity Visual Design Illustration

METHODOLOGY

The process used to identify, gather, and analyse data, resulting in a result based on observation, is known as a research methodology. And this is a combination of ways. Quantitative and qualitative methods are both available. Quantitative analysis is a technique for determining reciprocal frequencies as different quantitative factors to understand a phenomenon (Maxwell, 2008). Quantitative Technology is a sort of research that can be used when the investigation's estimate is uncertain. Digital film after creation is one of the required courses in movement creation and plan, advanced media, and different degrees. The poll addressed in this article is for college undergraduates who have partaken in computerized picture combination studies advanced film because of this setting.

This questionnaire was issued to 136 people, and 125 of them were recovered, resulting in a 91.91 percent recovery rate. Following the rejection of unqualified surveys, 113 valid questionnaires were employed, resulting in an effective rate of 90.4 percent. The next step was to choose 50 students for interviews and interviews. The poll is about the present state of virtual reality in post-production for cinema and television.

The content of the questionnaire survey focuses on whether virtual reality technology can be used to shape the role and ambience of a scene, the technical benefits of virtual reality technology in film and television production, and the issues that can arise. The results of the questionnaire survey were collated, documented, and analysed. According to a review of the current state of VR virtual reality, there are several challenges and flaws.

Based on a statistical analysis of the number and quality of virtual reality image studios in recent years in film production. Shortly the potential of this hardware situation, as well as the film behind the subsequent market, can be created in the piece, SPSS and SmartPLS were used. Virtual reality picture innovation is a three-layered virtual climate made with PC innovation. This innovation can upgrade the client experience by turning films, movements, and games into three-layered objects. Clients can have a vivid involvement in motion pictures and games. That, however virtual reality innovation can modify the sound too. Thanks to the same technology that enables visual television, sound can accomplish television effects. The advancement of virtual reality picture technology has resulted in massive digital cinema and television post-production.

DATA ANALYSIS

The findings of the questionnaire are sorted and classified using a questionnaire survey of students who have participated in digital image synthesis majors in the special effects production of digital film and television in this area, which includes experimental results and analysis.

Table 1 shows the 113 respondents' profiles. Their personal information was collected to analyse the characteristics of the respondents. The results clearly show that males account for the biggest percentage (74.4%), followed by females (25.6%). Males accounted for a larger percentage of the total. The results demonstrate that these findings' viewpoints are well-received.

Table1. Respondents Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	67	74.4	74.4	74.4
	Female	46	25.6	25.6	100.0
	Total	113	100.0	100.0	

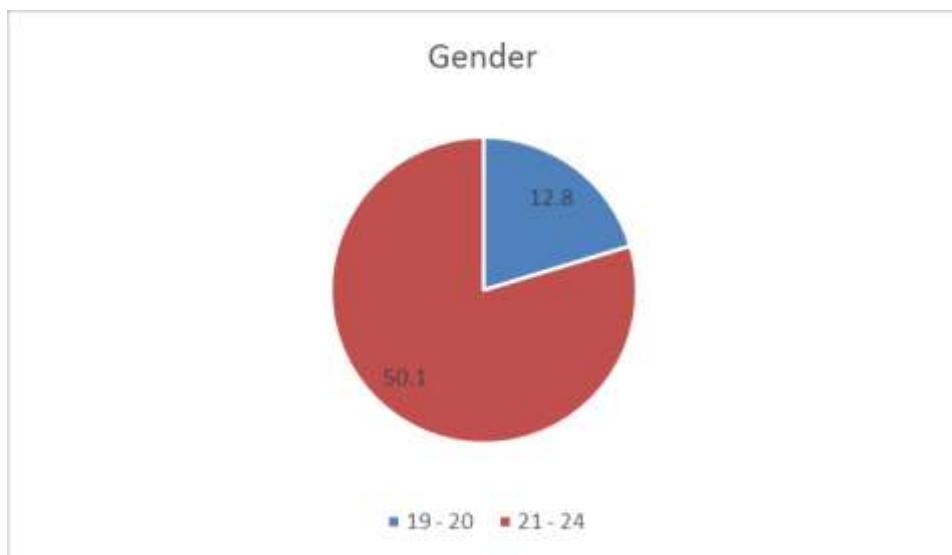


Figure 4: Respondent gender

Table 2 shows the 113 respondents' profiles. Their personal information was collected to analyse the characteristics of the respondents. The results clearly show that the biggest percentages are 21 – 24 (50.1%), 25 – 30 (21.1%), 31 and above (15.0%) and 19 – 20 (12.8%). The results suggest that the percentages in the 21–24 age groups were higher. The results demonstrate that these findings' viewpoints are well-received.

Table 2. Respondents Age

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid				
19 - 20	13	12.8	12.8	12.8
21 - 24	46	50.1	50.1	52.1
25 - 30	29	21.1	21.1	35.1
31 and above	25	15.0	15.0	100.0
Total	113	100.0	100.0	

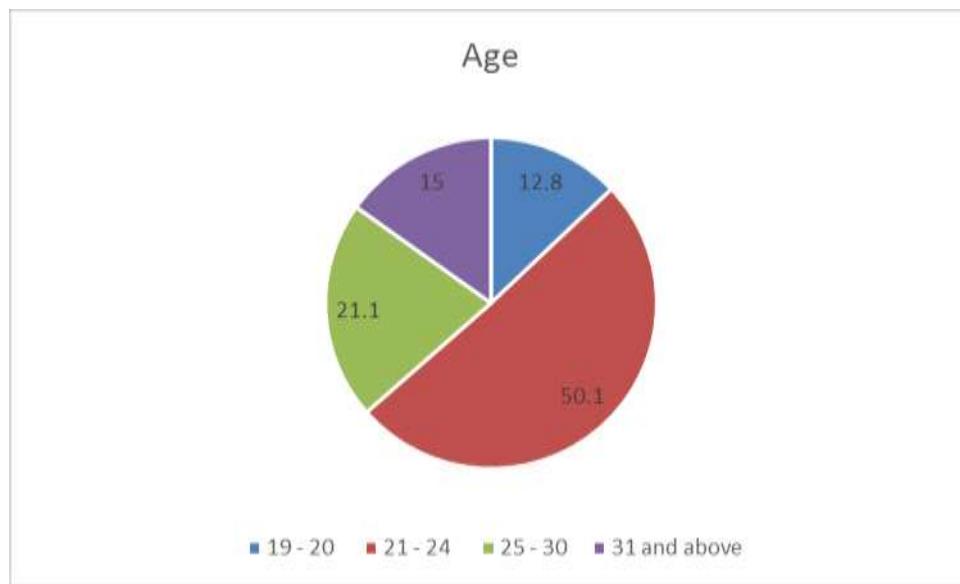


Figure 5: Respondent Gender

Table 3 show the current state and problems of digital cinema and television post-production, as well as the development of virtual reality image technology.

Table 3. Survey results of VR virtual reality in film and television post-production Content

Content	Identify	Disagree	Percentage
VR virtual reality to the shaping of the characters for help	109	4	96.46%
VR virtual reality is helpful to the atmosphere of the scene	111	2	98.23%
VR virtual reality is not affected by the weather, light and other effects, improving production efficiency	92	21	81.42%
VR virtual reality reduced film and television production costs	97	16	85.84%
The application of VR in post-production makes the works more colorful	107	6	94.69%



Figure 6. Results of a questionnaire survey of VR virtual reality in film and television post-production.

Figure 6 illustrates this. Virtual reality, according to 95.48 percent of students, is unaffected by weather or light, which improves post-production efficiency. According to 93.62 percent of students' occlusion modifications, the usage of VR virtual reality has lowered the cost of film and television production. Virtual reality (VR) colour changes are good for character development, according to 94.37 percent of pupils. Furthermore, students agree that virtual reality has an impact on the setting and atmosphere of a scenario. According to 94.69 percent of pupils, using virtual reality in cinema makes the work more colourful.

Table 4. Visualization in different situations

X

Visualization in different situations.				
Number of images	Lighting changes (%)	Occlusion changes (%)	Color change (%)	No change (%)
50	95.48	93.62	94.37	98.12
100	94.49	93.38	93.48	97.83
150	92.51	92.29	92.19	96.68

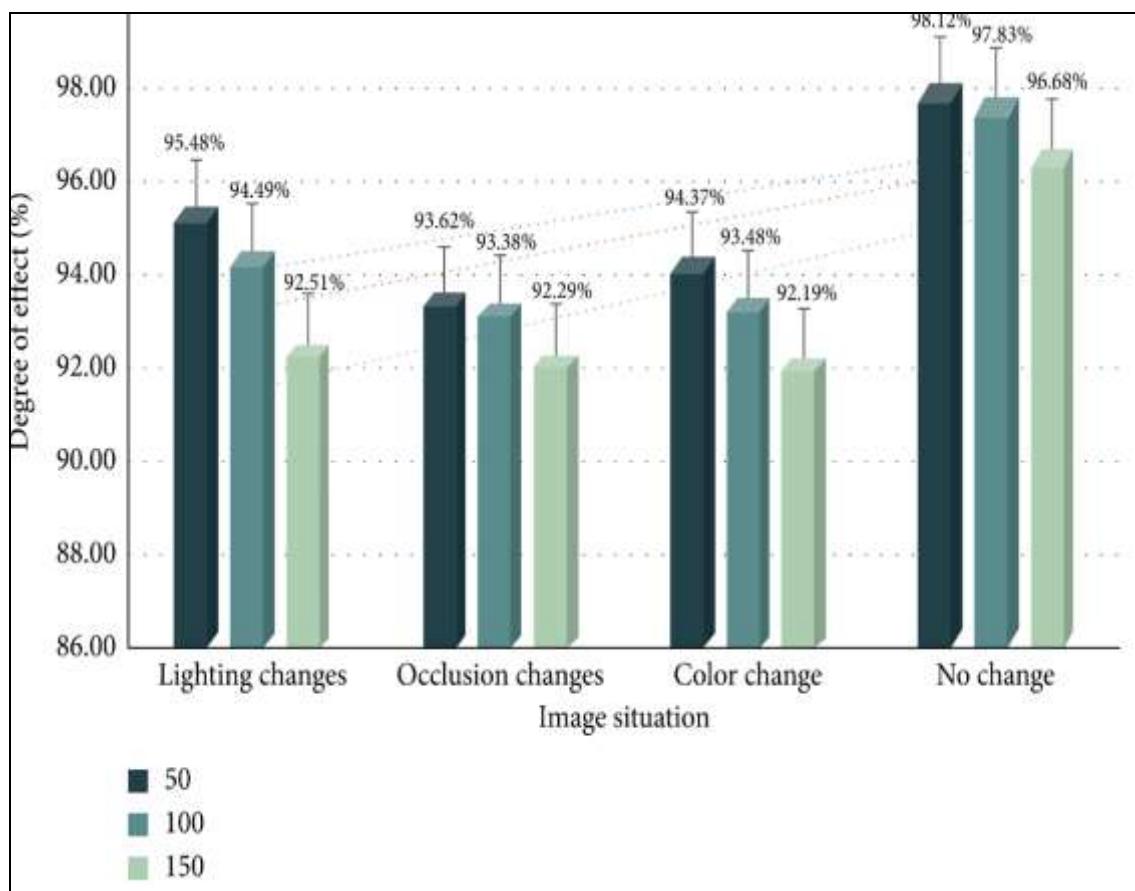


Figure 7. Bar chart Visualization in Different Situations

Art image design is a creative discipline that focuses on the integration of visual representation, data, and ideas. Art image design technology is widely used in a variety of disciplines, including photography, calligraphy, geography, and motion graphics. To maximise and advertise their work, designers want art design innovation. Virtual reality (VR) is a new technology that genuinely shows concepts and hypothetical scenarios. In the sphere of the visual design of artistic imagery, VR technology is far more effective. Multiple people or virtual worlds in different physical locations can connect to a system that distributes information through a network using this technology.

Table 5 shows the audience's expectations for VR films and television based on the survey results. The majority of people are still excited about virtual reality films and television.

Overall positive trend toward VR based on
all
changes
+
encouraging
desire
already
existing
in people.

Audience Statistics on VR Film and Television Audience Evaluation	ratio
Very rubbish	2.11%
general	8.23%
Very fresh form	37.61%
Very good	52.08%

DISCUSSION

Art image design, according to analysis, is a creative profession that works with the integration of visual representation, information, and ideas. Most students feel that VR virtual reality is unaffected by weather or light, which improves post-production efficiency, based on student outcomes. Film and television production costs have been decreased thanks to the usage of virtual reality (VR) and occlusion modifications. Colour changes in virtual reality (VR) are important for character development.

Furthermore, art image design is a creative field concerned with the integration of visual representation, data, and ideas. Photography, calligraphy, geography, and motion graphics are just a few of the fields that use art image design technology. Designers require art design innovation to maximise and advertise their work. Virtual reality (VR) is a new technology that displays concepts and hypothetical scenarios in a realistic manner. VR technology is significantly more effective in the field of the visual design of artistic graphics. Multiple persons or virtual worlds in various physical locations can connect to a system that uses technology to communicate information through a network.

Finding novel ways to show graphical data in a more engrossing manner is one of the primary difficulties in visualisation and aesthetic picture design. Virtual reality technology is capable of engrossingly representing actual or imagined scenarios. Finally, the study compares it to traditional art image visualisation design and concludes that virtual reality technology is crucial for art image visualisation design.

CONCLUSION

- In conclusion, this study has examined the post-production of digital film and television with the development of virtual reality image technology. Where virtual reality image technology filled the scopes of film and television effects. It extended the content of film and television. And enhanced the method and effect of film and television made. another. It has enjoyment. Help to attract students to the desire to learn. There is virtual reality image technology. Photographing characters and virtual objects can also create interactive images. Produces an extraordinary effect. There is no doubt that in the future virtual reality technology will be useful to other industries such as healthcare, the military and construction are leading the way.

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Article

Using an Artificial-Intelligence-Generated Program for Positive Efficiency in Filmmaking Education: Insights from Experts and Students

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Improve filmmaking
world through
education.



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Abstract: In recent years, despite the widespread success of artificial intelligence (AI) across various domains, its full potential in the field of education, particularly in filmmaking education, remains largely untapped. The purpose of this study is to explore the application of AI-generated programs in filmmaking education to address existing shortcomings in curriculum design. We employed a comprehensive approach, starting with an extensive review of existing filmmaking courses and AI-recommended courses. Subsequently, two rounds of in-depth interviews were conducted, involving both experts and students, to gain profound insights. We utilized user journey maps to visualize the participants' experiences and feedback, complemented by a mixed-methods analysis approach for a comprehensive data assessment. The study revealed that both the experts and the students derived positive benefits from AI-recommended courses. This research not only provides a fresh perspective on the practical applications of AI in filmmaking education but also offers insights for innovation in the field of education. Theoretically, this study establishes a new foundation for the application of AI in education. In practice, it opens up new possibilities for filmmaking education and promotes the development of cutting-edge teaching methods. Despite limitations in sample size and geographical scope, this study underscores the immense potential of AI in filmmaking education. It provides directions for future research to deepen our understanding of AI's impact on education.

Keywords: design education; artificial intelligence; experience design; positive efficiency; experience journey

1. Introduction

In recent years, artificial intelligence (AI) has witnessed remarkable advancements, revolutionizing various industries and domains, including education [1]. From intelligent algorithms in the financial sector to diagnostic tools in healthcare and autonomous vehicles in transportation, artificial intelligence (AI) has demonstrated immense potential across various domains. However, despite its remarkable strides in many fields, the application of AI in the realm of education has lagged behind [2]. The education sector is gradually realizing that AI can not only be used to optimize school and student management but can also fundamentally transform the essence of education itself. This awareness is driving educators and researchers to actively explore how AI can enhance learning methods, improve curriculum efficiency, and personalize the student experience. The AI's potential to transform traditional educational practices and enhance learning experiences has sparked interest among educators and researchers. In recent years, large language models like ChatGPT have emerged as prominent representatives in the fields of natural language processing and artificial intelligence. These models have not only achieved significant success in business and research but have also garnered increasing interest in higher education. As a forward-looking educational tool, large language models are reshaping the landscape of

Justifying the Concentration between Film and Tech

education, fostering innovation in both learning and teaching [3]. Against this backdrop of educational transformation, our focus is directed towards the field of higher education in filmmaking—a domain characterized by creativity, technicality, and constant evolution. Filmmaking is not merely an art but also a technical discipline that integrates literature, visual arts, music, and technology. It stands as an interdisciplinary field in which creativity, technical skills, and adaptability are of paramount importance. Students receiving a filmmaking education must cultivate creativity, master the art of cinematography and post-production techniques, and remain adaptable to the ever-changing preferences of their audience. The integration of AI tools holds the promise to optimize curriculum design and foster personalized learning for aspiring filmmakers and could trigger a fourth educational revolution [4].

It goes without saying that the world is currently experiencing a sustained and ubiquitous technological revolution. Fueled by these technological innovations and ever-evolving audience preferences, the filmmaking industry is dynamic and continuously evolving [5]. The emergence of technological innovations, the rise of digital media, and the diversification of audience preferences have presented both new challenges and opportunities in the field of filmmaking. In order to equip students with the competitiveness required for successful employment, filmmaking education must adapt to these changes to ensure that graduates are capable of performing effectively in a variety of job roles. However, addressing these changes within an educational environment, delivering the required skills and knowledge to students, and designing a comprehensive and highly adaptable curriculum to meet the evolving demands of the industry is a challenging task [6].

The focus of this study is on exploring the potential benefits of incorporating AI tools into higher education in filmmaking to address the aforementioned challenges. Specifically, we aim to investigate how AI-generated advice can improve the effectiveness and timeliness of courses. Our study centers on three fundamental stages of film production education. The basic stage serves as the building block, introducing students to essential concepts and technical skills. Courses in “Audiovisual Language” provide deep understanding of the visual and auditory elements that shape cinematic storytelling, while “Post-production Techniques” equip students with the necessary skills to refine and enhance the final product. The practical stage allows students to apply their knowledge and skills in real-world scenarios. Courses like “Film Production Practice” provide hands-on experiences in various aspects of filmmaking, and “Scriptwriting” nurture creativity and storytelling abilities, which are essential for aspiring filmmakers. Finally, the studio project stage enables students to work on ambitious and collaborative projects. Here, the students can demonstrate their accumulated knowledge and skills in a more comprehensive manner. The “Film Studio Project” course serves as a culminating experience, encouraging students to tackle complex challenges and refine their artistic vision.

To evaluate the impact of AI-generated course recommendations on the curriculum, we conducted interviews with film production experts and students. By showcasing both the original curriculum and AI-recommended alternatives, we sought valuable insights and feedback from participants. The study also involved creating a user journey map to visualize the experts' and students' experiences and emotional responses throughout their journey. This research contributes to the ongoing discussion about the use of AI in educational settings and highlights innovative ways to improve the filmmaking curriculum for students. The integration of AI tools is envisioned not as a replacement for educators but as a strategic partnership to support and enhance the curriculum design process [7]. The following sections of this study discuss related research, the research methodology employed in this study, interview findings, and user journey maps. These sections provide valuable insights from experts and students regarding the potential benefits and challenges of using artificial intelligence in filmmaking education. We believe that the findings of this study will provide valuable insights for future research and educational practices. These insights aim to create a more adaptive and empowering learning environment for students

aspiring to enter the field of filmmaking, enabling them to thrive and embrace the various challenges and opportunities presented by the filmmaking industry.

2. Literature Review

2.1. The Integration of AI into Education

The rapid advancement of artificial intelligence technology has had a profound impact on various aspects of human society, including the economy, social systems, science, and education. AI has been applied to diverse tasks in different domains, such as software engineering [8], data augmentation [9], medical education [10], code generation [11], and autonomous vehicles [12], addressing various AI tasks [13]. In the realm of education, which is our primary focus, the application of AI technology can be traced back to the last century when the first intelligent tutoring system, "SCHOLAR", aimed to support learning geography and could interact with students to some extent. These early attempts paved the way for the integration of AI technology with education. In recent years, AI has evolved from a mere academic research tool into a powerful ally for both educators and students. AI shows great promise in addressing some of the challenges faced by educators and students, bringing new possibilities to the field of education.

In the current surge in the discussion around the role of AI in education, Moreno-Guerrero et al. analyzed the literature on AI in education based on research published between 1956 and 2019. They found that earlier research focused more on the technical process, but more recent research focused on the development of AI in the teaching process [14]. In recent years, the majority of researchers have focused on the applications of artificial intelligence in various aspects of education. These areas include promoting personalized learning, providing teaching support, managing extracurricular activities, assessing projects, aiding in academic writing and data analysis, offering virtual experiments and simulations, and enhancing plagiarism detection. For instance, artificial intelligence is being used to consider students' strengths, weaknesses, and individual learning styles, thereby enabling the creation of personalized learning pathways which are tailored to each student's needs [15]. Education professionals can also harness the power of artificial intelligence for swift assignment assessments, which saves them a significant amount of time [3]. AI is being employed to enhance students' writing and research skills by providing immediate answers and support for interdisciplinary research projects. This includes features like grammar and spelling checks, which assist students in improving the quality of their writing and reduce inadvertent citation errors, thereby providing robust tools and resources for academic writing and research [16]. By analyzing vast amounts of data from past projects and educational outcomes, AI aids educators in making data-driven decisions to optimize the learning experience [17]. AI-driven virtual environments further enable students to intuitively explore their design concepts, deepening their understanding of spatial relationships and user interactions [18]. Furthermore, artificial intelligence algorithms can assess design projects based on aesthetic principles, usability, and audience engagement [19]. The design recommendations and inspiration generated by AI can expand students' creative horizons and enhance their ideation phase [20]. When discussing the application of artificial intelligence in higher education, another crucial aspect to consider is its role in plagiarism detection and academic integrity. Artificial intelligence plays a significant role in detecting and preventing academic plagiarism and unethical behavior. It analyzes a submitted text, compares it with extensive literature databases literature, and identifies any similarities. This plagiarism detection not only helps uphold academic ethics but also provides educational institutions with effective means to ensure academic integrity [21]. Conversely, many researchers also focus on issues of ethics and integrity with respect to the use of artificial intelligence for academic writing, sparking extensive discussions [22–24]. For the convenience of researchers, we summarized a list of some research articles on the use of AI in higher education in Table 1.

Table 1. List of articles addressing the use of AI in higher education.

Category	Article	Citations	Description
Management system	Popenici et al. [25]	286	Identify some of the challenges in using AI technologies for teaching, learning, student support, and management
	Ge et al. [26]	11	AI for the creation of teaching management methods for higher education
	Maria et al. [27]	20	System for AI-based student diagnosis, assistance, and evaluation
	Ming et al. [28]	11	Assess the quality of education
	Jain et al. [29]	72	Assess a student's understanding of a topic
Teaching support	Lin et al. [30]	37	An intelligent counseling system that detects emotions
	Ocaña-Fernández et al. [31]	82	The digital language popularization of AI
	Bates et al. [32]	118	Potential and actual implications for higher-education teaching
	Kong [33]	62	A model was designed to quantify the effect of applying AI in teaching art
	Saplaican et al. [34]	12	Digital interfaces use design to evoke positive emotions
Academic writing	Dekker et al. [35]	28	The potential of AI to improve academic performance
	Frieder et al. [36]	130	Evaluate the help of AI in mathematics education
	Gilson et al. [37]	50	Evaluate the aid of AI in medical education
	Nazari et al. [38]	82	An AI-driven writing tool can be an effective tool
	Salvagno et al. [16]	183	The aid of AI in academic writing
Virtual experiments and simulations	Mirchi et al. [39]	154	AI tools are used for surgical and medical simulation training
	Janpla et al. [40]	8	Testing the use of AI in e-learning environments
Personalized learning	Meng et al. [41]	42	Personalized content for students
	Villegas-Ch et al. [42]	97	Stimulating students' interest in learning
	Thomas et al. [43]	63	Dynamically adjusted to suit individual learners
Plagiarism	Gao et al. [21]	177	Comparing scientific abstracts generated via ChatGPT to original abstracts
	Mohammad et al. [22]	78	Detecting plagiarism in academic papers generated via AI

We primarily focused on the use of artificial intelligence in course-related tasks in higher education. Some researchers have experimented with using AI to create course outlines for specific courses. For instance, they have asked ChatGPT to "prepare a detailed syllabus for the Algorithm and Data Structures course." ChatGPT can generate a comprehensive outline for the course, including topics, subtopics, and learning objectives [44]. Additionally, some researchers have explored the use of artificial intelligence in career-planning courses in higher education. They employed AI to recommend courses to students and conducted intergroup experiments. The results revealed that the AI recommendations positively impacted the students' learning and career planning [45]. Due to the novelty of the topic and the fact that most researchers have been focusing on applying artificial intelligence in areas like personalized learning, teaching and academic support, and plagi-

rism and cheating, little work has been carried out in the field of course administration in higher education.

2.2. Filmmaking Education and the Integration of AI into Education

Over the years, the field of filmmaking education has witnessed significant development. Filmmaking is a unique and creative art form that holds a special place in the realm of creative expression. It encompasses a wide range of design elements, from scriptwriting and set design to cinematography and visual effects, and each aspect requires meticulous planning to convey specific emotions and stories [46]. Education plays a pivotal role in nurturing talent for filmmaking, providing the necessary knowledge and skills that enable creators to effectively utilize design elements to convey their creativity. It encompasses not only technical training but also the cultivation of creative thinking and storytelling, which are vital aspects of filmmaking [47]. Students will explore various aspects of filmmaking, including scriptwriting, cinematography, sound design, and editing. They will apply theoretical concepts to real-world scenarios through individual or collaborative projects [48].

The field of filmmaking education also faces a series of challenges, including the rapid evolution of digital tools and technologies, as well as the importance of project management in filmmaking. The emergence of new post-production software and visual effects tools demands that students master these tools to remain competitive in the future filmmaking industry [49]. The integration of Virtual Reality (VR) and Augmented Reality (AR) technologies poses new challenges for filmmaking education as students need to understand how to create within virtual environments [50,51]. The emergence of new technologies and tools has expanded the possibilities of filmmaking. However, facing this array of technologies, there is a concern about whether students might become overwhelmed during their filmmaking education. How can a balance be struck between teaching these technologies and nurturing creativity within the constraints of the students' limited curriculum [52]? In addition, project management in the field of filmmaking is an aspect that cannot be overlooked [53]. Students can learn how to analyze film data and collaborate with colleagues on film projects. Many professionals in the film industry have faced a lack of competitiveness upon entering the field due to inadequate preparation in these essential skills during their education. The current curriculum models in university filmmaking programs shape the professional learning of future filmmakers. To ensure that they can adapt to the constantly evolving film industry, we must be vigilant about "existing" models. In order to provide students with the most meaningful and suitable educational environment, we need to be willing to break free from restrictive frameworks and rigid assessment methods within the education system [54].

2.3. The Role of AI in Enhancing Filmmaking Education

The interaction between filmmaking and artificial intelligence (AI) has a rich history and an evolving present. As far back as the 1950s and 1970s, the filmmaking industry was exploring the potential of AI technology, using computer-generated special effects and animations, as seen in the 1968 film *2001: A Space Odyssey* [55]. The 1980s and 1990s witnessed the rise of Computer-Generated Imagery (CGI), which provided new visual possibilities for filmmaking. The emergence of this technology allowed filmmakers to create visual effects that were previously impossible, as seen in films like *Jurassic Park*, which featured lifelike dinosaurs [56]. Indeed, while these effects were primarily based on programming and algorithms, they can be seen as precursors to AI technology. With the rapid advancement of computer technology, AI has been extensively utilized in various post-production aspects of filmmaking in the 21st century. These include audio and video editing, color correction, visual effects composition, and scene generation [57]. Furthermore, AI has also begun to make its mark in the composition of film music, generating original music by analyzing emotions and plotlines [58]. In recent years, AI technology has even ventured into the realms of generating movie scripts and designing characters [59].

Expansion of AI in Film

Ethical issues of AI?

Film recommendation systems have also harnessed the power of AI, personalizing movie recommendations through the analysis of viewer data [60].

Despite the current limitations of AI technology, the scope of AI applications in the field of filmmaking is continuously expanding. This trend presents innovative opportunities for filmmaking and foreshadows AI's continued significance in movie production in the future.

AI not only plays a role in the filmmaking process but also offers interesting applications in filmmaking education [61]. The field of filmmaking education has been constantly seeking innovative teaching methods and tools to adapt to evolving industry demands. The rapid development of artificial intelligence technology has brought new opportunities and challenges to filmmaking education [62]. In filmmaking education, AI can analyze students' learning habits, interests, and academic backgrounds to provide personalized course recommendations which are tailored to each student's learning needs. This personalized learning path can enhance students' motivation and engagement. Additionally, AI can predict the skills and knowledge that might be needed in the future by analyzing trends and developments in the film industry. This information can assist educational institutions in adjusting their course content to align with industry demands [63]. However, as we discussed earlier in a general context about the integration of AI into education, the academic literature on AI's involvement in course design in higher education is very limited, and even fewer resources are available regarding course design in filmmaking education. The introduction of AI into filmmaking education has sparked discussions among many researchers, including concerns about the reliability and accuracy of the technology [57]. Questions about whether AI's recommendations genuinely suit each student and how AI ensures its suggestions are based on accurate data and analysis are essential considerations. Furthermore, while AI can provide insights into course design, the experience and creativity of human educators remain indispensable in the course design process [64].

The use of artificial intelligence to assist in developing more effective and relevant courses in curriculum design and educational planning has the potential to significantly enhance the quality of film production education.

3. Method

An overview of this study's research methodology this study is shown in Figure 1. In order to achieve a more global and generalized perspective, we conducted desk research on prominent universities in China, Europe, and the United States which are known for their influential filmmaking programs. The United States, Europe, and China represent different cultures, educational systems, and methodologies, and different regions may influence the content and methods of filmmaking education. Therefore, universities in different cultural contexts can provide diversity and contribute to the understanding of cross-cultural differences in filmmaking education. The United States, Europe, and China each have significant influence and representation in the field of filmmaking. The selection of these universities for study facilitates the identification of key global trends and developments in filmmaking education for the purpose of obtaining more comprehensive, diverse, and representative data and insights.

The desk research focused on dissecting the filmmaking education process into three stages: basic, practice, and studio. Within each stage, we identified the key courses offered by these comprehensive universities. Subsequently, we sought an AI program's recommendations for course enhancements, and the AI provided its insights.

3.1. Filmmaking Education in Prominent Universities

First, we selected universities with top overall scores in each region based on the QS World University Rankings by Subject Classification. Secondly, the topic of our study included filmmaking education and AI. Considering that filmmaking is a comprehensive discipline, we excluded specialized colleges like the American Film Institute from our examination of candidate universities, and we also considered whether any of the candidate

*Actual research were or less irrelevant
per my topic, but paper provided*

good examples of film tech in use !!!

universities had established AI-related majors; this consideration also encompasses our possible future research on the combination of AI with specific curricula in filmmaking majors. In the examination of candidate universities, we also considered factors such as whether we could find the real curriculum of these universities, the talents trained in the film industry, and so on. Over the course of conducting the desk research, we identified two universities in each of the three regions. They are New York University (US), the University of Southern California (US), the University of Bristol (Europe), Bath Spa University (Europe), Beijing Normal University (China), and the Communication University of China (China). We collected the courses offered by these universities at different stages of filmmaking education and selected core courses at each stage.

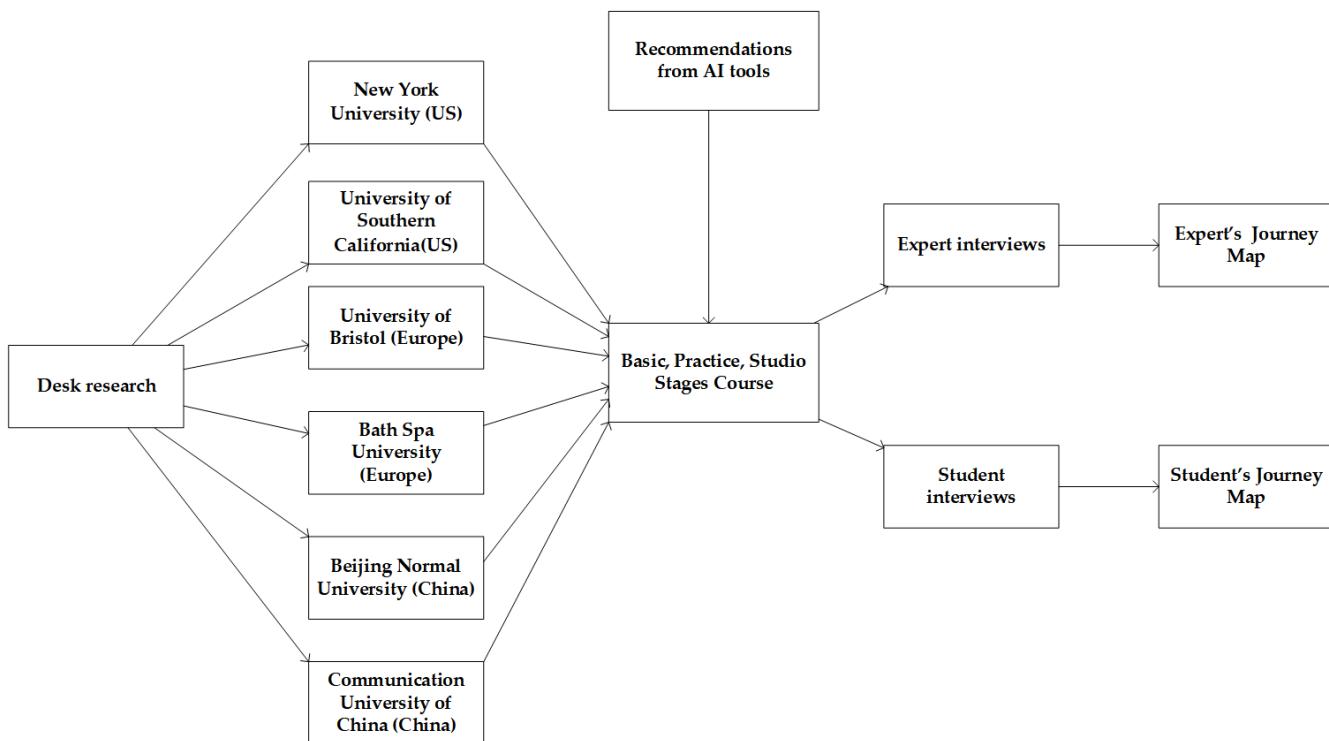


Figure 1. Research method.

3.1.1. Basic Stage Courses

At the foundational stage, universities lay the groundwork for their students' cinematic journey. Core courses often include the following:

- Directing language and technique;
- Editing and post-production;
- Screen performance;
- Digital creativity and content creativity.

3.1.2. Practice Stage Courses

The practice stage is when students apply theoretical knowledge to hands-on filmmaking experiences. Courses in this stage comprise the following:

- Script writing;
- The production of short films;
- Practicum in cinematography;
- The production of short films.

3.1.3. Studio Stage Courses

The studio stage involves more complex projects and collaborative endeavors. The courses offered at this stage encompass the following:

- Directing and film creation;
- Documentary creation;
- Cinematic arts laboratory;
- Collaborative group projects;
- Industrial research projects.

The main courses for each of the three phases are shown in Table 2 by university region.

Table 2. Desk research.

Area	Basic		Practice		Studio	
China	Directing Language and Technique	Editing and Post-Production	Script Writing	Production of Short Films	Directing Film Creation	Documentary Creation
US	Photography and Imaging	Cinematic Communication	Practicum in Cinematography	Production and Post-Production	Cinematic Arts Laboratory	Advanced Production Workshop
Europe	Digital Creativity and Content Creativity	Screen Performance	Scripting for Screen	The Production of Short Films	Collaborative Group Projects	Industrial Research Projects

3.2. AI Recommendations for Course Enhancement

In this phase, we employed the capabilities of the AI (ChatGPT) to propose potential improvements for the existing courses. When we initially asked ChatGPT about its recommendations for filmmaking education, we attempted to ask ChatGPT directly what courses are important in a filmmaking major's curriculum, but ChatGPT's initial response did not satisfy us, and it listed almost all of the types of courses that filmmaking majors would take in university, as shown in Figure 2.

This generalized response did not help much in the attempt to integrate AI into filmmaking education. In addition to asking ChatGPT which courses are important, we tried asking it what dimensions the courses in the filmmaking program can be categorized into, and what the core courses are in each dimension. With the addition of commands such as "categorize" and "dimensions", ChatGPT's responses were more accurate than the initial responses, as shown in Figure 3.

After several attempts, it was found that the AI ChatGPT provides more effective advice with accurate instructions. We decided to allow ChatGPT to provide recommendations for filmmaking education based on our desk research, as in Figure 4.

After ChatGPT provided its recommendations for the curriculum in filmmaking education, we asked it again about its reasons for providing such recommendations, which were organized and presented to the experts and students via the interviews. The Q&A with ChatGPT is shown in Figure 5, and to increase its readability, we also included part of the text from the process of interacting with ChatGPT in the Appendix B.

The AI, with its analytical prowess, recommended adjustments that could align courses more closely with industry trends and emerging technologies. Realistic courses and the AI tool's responses for courses are shown in Table 3.

3.3. Research Design

The research method of conducting in-depth interviews was used in this study to obtain qualitative data; this involved a comprehensive, two-round interview process. The objective was to gather insights from both industry experts and filmmaking students regarding the potential enhancements to filmmaking education achieved using AI recommendations.

MS What are the most important courses in a university filmmaking major?

 In a university filmmaking major, the most important courses typically include the following:

- Filmmaking and Directing Courses:** These courses teach the core skills of filmmaking, including directing, cinematography, screenwriting, producing, and editing. Students learn how to conceptualize, plan, and execute film projects.
- Screenwriting Courses:** These courses teach students how to write various types of scripts, including plot development, character creation, and dialogue writing. A well-crafted script is the foundation of a successful film.
- Cinematography and Camera Courses:** Students learn techniques in cinematography, lens selection, camera operation, and lighting setups to effectively capture visual storytelling.
- Editing and Post-Production Courses:** These courses cover the post-production process of filmmaking, including film editing, visual effects, sound design, and scoring.
- Film Analysis and Criticism Courses:** Students learn how to analyze films and understand the history, theory, and aesthetic principles of filmmaking. This helps them develop critical thinking about films and insights into their own creative work.
- Film Production Practicum Courses:** These courses often involve hands-on experience in producing short films or projects, from creative conception to the final product.
- Film History and Theory Courses:** These courses explore the history of film, genres, cultural influences, and theoretical frameworks, helping students understand the evolution and diversity of cinema.
- Acting Courses:** Particularly for directors and those interested in working with actors, acting courses can improve performance skills and directorial guidance.

These courses typically form the core curriculum of a filmmaking major, providing students with the necessary skills and knowledge to prepare for their careers. However, the specific course offerings can vary by university and program, so students should research the course requirements and content of each school when selecting their major and institution.

Figure 2. Course improvement recommendations generated through ChatGPT-3.5 1.**Table 3.** Realistic courses and the AI tool's response to the course.

Area	Basic		Practice		Studio	
China	Directing Language and Technique	Editing and Post-Production	Script Writing	Production of Short Films	Directing Film Creation	Documentary Creation
US	Photography and Imaging	Cinematic Communication	Practicum in Cinematography	Production and Post-Production	Cinematic Arts Laboratory	Advanced Production Workshop
Europe	Digital Creativity and Content Creativity	Screen Performance	Scripting for the Screen	Production of Short Films	Collaborative Group Projects	Industrial Research Projects
AI	Appreciation of Film Art	Fundamentals of Film Choreography	Scriptwriting and Analysis for film	Film Photography and Videography	Directing Practice and Film Creation	Film Practice and Project Management

MS How many dimensions can a course of study in a filmmaking major at a university be categorized into?

A course of study in a filmmaking major at a university can be categorized into several dimensions, typically covering a range of knowledge and skills areas. While the exact number of dimensions may vary depending on the university and the specific program, here are the primary dimensions commonly found in filmmaking majors:

1. **Core Production Skills:**
 - **Directing and Screenwriting:** Focusing on the skills of film direction and scriptwriting, teaching students how to conceptualize stories and translate them into scripts before directing the actual shooting.
 - **Cinematography and Camera Operation:** Covering cinematography techniques, camera operation, lens selection, and lighting skills to effectively capture visual narratives.
 - **Editing and Post-Production:** Teaching students film editing, visual effects, sound design, and music composition for post-production processes.
2. **Creative and Artistic Aspects:**
 - **Screenwriting:** Teaching students how to create stories, characters, and dialogues and construct engaging plots.
 - **Art and Design:** Including art direction, costume design, and set design for building the visual elements of a film.
 - **Music and Sound Design:** Focusing on how to use music and sound to enhance the emotions and atmosphere of a film.
3. **Theory and Analysis:**
 - **Film History and Theory:** Covering the history, culture, and theoretical frameworks of film, exploring the evolution and diversity of the art of cinema.
 - **Film Analysis and Criticism:** Teaching students how to analyze films and present critical viewpoints, fostering critical thinking about cinema.
4. **Production Practice:**
 - **Production Labs and Projects:** Providing students with practical experience through actual filmmaking projects, from creative concepts to final productions.
 - **Acting Directing:** For students interested in directing actors, this dimension involves learning how to guide and direct performances.
5. **Film Industry and Business:**
 - **Producing and Film Management:** Teaching how to plan, budget, and manage film production projects, including legal and business aspects.
 - **Marketing and Film Distribution:** Understanding how to market and distribute films to audiences, including marketing strategies, distribution, and programming.

These dimensions collectively provide students with a comprehensive education in filmmaking, covering creative, technical, theoretical, and industry-related aspects. Universities may integrate these dimensions differently, and the specific courses offered can vary between programs. Students often choose courses based on their interests and career goals within the field of filmmaking.

Figure 3. Course improvement recommendations generated through ChatGPT-3.5 2.

The research design centered on the collection of qualitative data through semi-structured interviews. The interviews were conducted on a one-to-one basis, using a semi-structured methodology, and were limited to 40 min per interviewer. This allowed for a consistent set of core questions while also permitting flexibility to explore unique perspectives. The interview questions were customized according to the expertise of each group of experts and students, and an Interview Guide containing the contents of the interviews is attached as Appendix A.

MS This is the desk research study we did, it is the subject curriculum of the filmmaking majors in the university in three stages of courses: basic, practice and studio (Chins; basic stage: Directing Language and Technique, Editing and post-production; practice stage: Script writing, Production of short films; studio stage: Directing Film Creation, Documentary Creation; USA; basic stage: Photography and Imaging, Cinematic Creation; studio stage: Directing Film Creation, Documentary Creation; and studio stage: Photography and Imaging, Cinematic Creation. Writing, Production of short films; Studio stage: Directing Film Creation, Documentary Creation; USA; Foundation stage: Photography and Imaging, Cinematic Communication; Practicum in Cinematography, The Production and Post-Production; Studio: Cinematic Arts Laboratory, Advanced Production Workshop. Workshop; Europe; Foundation Stage: Digital Creativity and Content Creativity, Screen Performance; Practicum Stage: scripting for Screen, Production of short films; Studio Stage: (Collaborative Group Projects, Industrial Research Projects). How would you like to improve the three stages of the curriculum?

It appears you are seeking suggestions to improve the three stages of the curriculum for filmmaking majors in universities based on your desk research findings. Here's a breakdown of potential improvements for each stage:

Basic Stage:

1. **Appreciation of Film Art:** Consider including a course that focuses on the history and evolution of cinema, helping students gain a deeper understanding of the medium's artistic aspects.
2. **Fundamentals of Film Choreography:** Introduce a course that covers the basics of film choreography and composition, which are crucial for creating visually compelling content.

Practice Stages:

1. **Scriptwriting and Analysis for Film:** Expand the scriptwriting course to include in-depth analysis of film scripts from different genres and eras. This will help students develop a more critical and analytical approach to screenwriting.
2. **Film Photography and Videography:** Combine photography and videography into a comprehensive course that covers both still and moving images. This integration can provide a more holistic understanding of visual storytelling.

Studio Stage:

1. **Directing Practice and Film Creation:** In the directing practice course, emphasize hands-on experience in directing short films. Provide students with opportunities to apply their skills in real-world filmmaking projects.
2. **Film Practice and Project Management:** Introduce a course that not only focuses on filmmaking techniques but also on project management skills. This course can prepare students for the practical aspects of working in the film industry, including budgeting, scheduling, and team management.

These improvements aim to enhance the overall curriculum by offering a more balanced and comprehensive education in filmmaking. They provide students with a solid foundation in film theory and practice while preparing them for the challenges of the film industry.

Regenerate

Send a message 

Free Research Preview. ChatGPT may produce inaccurate information about people, places, or facts. ChatGPT August 8 Version.

Figure 4. Course improvement recommendations generated through ChatGPT-3.5 3.

3.4. First-Round Interviews: Industry Experts

In the first round, we invited eight highly experienced experts from the filmmaking and education industries. To begin, we applied strict criteria during the sample selection process to ensure that our sample was sufficiently diverse and representative. We made an effort to include participants from a variety of geographic locations, cultural backgrounds, and educational levels, and we sought out interviewees from universities that were on the top list of filmmaking programs at comprehensive universities in each region. Secondly, we used a random sampling method by sending out e-mails to potential participants related to filmmaking inviting them to take part in this study to ensure that each potential participant had an equal opportunity to be included in the study. These experts possess a deep understanding of industry trends, technological advancements, and pedagogical practices.

The interviews were aimed at extracting the experts' insights into the existing filmmaking education landscape and their thoughts on the integration of AI-driven enhancements. Interviewer profiles are shown in Table 4.

MS Can you explain in detail on top of your answer why you gave such recommendations? And why the original was no good?

 Certainly, let me provide a more detailed explanation of the recommendations and why they were made, along with a brief analysis of the original curriculum:

Basic Stage:

- **Appreciation of Film Art:** The original curriculum might have lacked a course that focuses on the historical and artistic aspects of filmmaking. By introducing a course on the appreciation of film art, students can gain a deeper understanding of cinema's evolution, various cinematic movements, and influential filmmakers. This knowledge can help them develop a more nuanced perspective when creating films.
- **Fundamentals of Film Choreography:** The original curriculum may not have explicitly covered the basics of film choreography, which includes framing, composition, and camera movement. This recommendation ensures that students have a strong foundation in visual storytelling, helping them create more visually engaging films.

Practice Stage:

- **Scriptwriting and Analysis for Film:** While the original curriculum included a scriptwriting course, it might not have emphasized the importance of script analysis. By expanding the course to include script analysis, students can learn not only how to write scripts but also how to critically evaluate and improve existing scripts. This analytical skill is vital for becoming proficient screenwriters.
- **Film Photography and Videography:** Combining photography and videography into a single course can provide a more comprehensive understanding of visual storytelling. It ensures that students grasp the principles of composition, lighting, and visual aesthetics, both for still images and moving pictures. This integrated approach can lead to more well-rounded filmmakers.

Studio Stage:

- **Directing Practice and Film Creation:** The original curriculum likely focused on directing theory and concepts. The recommendation to emphasize hands-on experience in directing short films ensures that students can apply their knowledge in practical settings. This approach bridges the gap between theory and practice, preparing students for real-world filmmaking challenges.
- **Film Practice and Project Management:** The original curriculum might not have included coursework on project management, which is crucial in the film industry. This addition ensures that students not only learn filmmaking techniques but also gain essential skills in budgeting, scheduling, and team management. It equips them with the tools needed to navigate the logistical aspects of film production.

In summary, the original curriculum may not have been inadequate, but the recommendations aim to enhance it by addressing potential gaps and providing students with a more comprehensive and practical education in filmmaking. These changes ensure that students receive a well-rounded education that combines artistic and technical aspects, theory and practice, and creative and logistical skills, better preparing them for successful careers in the film industry.

Figure 5. Course improvement recommendations generated through ChatGPT-3.5 4.

Table 4. Overview of the respondents' profiles.

ID	Occupation/Field of Work	Profile	Experience in Using AI
IntE-1	University teacher; musician; director; script writer	PhD in music; 10 years in soundtrack production, film production creator	Familiar with AI practices and has experience with using AI for scriptwriting
IntE-2	University teacher; product designer	PhD in interaction design; 10 years of experience in prop making	Familiar with AI practice, has their own product design AI database, and is a technology enthusiast
IntE-3	University teacher; brand designer	PhD in interaction design; experience in film branding design	Familiar with AI practices but experience is limited to text-generation AI
IntE-4	University teacher; film director	PhD in interaction design	No experience with AI
IntE-5	University teacher; film director	PhD in artistic business; 14 years teaching film production courses at universities, directs films	Familiar with AI practices and has tried various AI tools in film production
IntE-6	University teacher	PhD in cinematography	Familiar with AI practices but limited to text-generation AI
IntE-7	University teacher	PhD in interaction design	Familiar with AI practices and has tested various AI tools in filmmaking
IntE-8	University teacher; visual communication designer	PhD in interaction design; 6 years of teaching experience in the Cinema Department	Familiar with AI practices and has tested various AI tools in filmmaking
IntS-1	University student majoring in film production	Has 3 years of learning experience in filmmaking	Has tested AI in several aspects of filmmaking
IntS-2	University student majoring in animation film	Has 4 years of learning experience in film animation	Has tested AI in several aspects of film animation
IntS-3	University student majoring in film directing	First-year student in the Film Directing Program	No experience with AI
IntS-4	Master's degree student at a university, earning a master's degree in filmmaking	Has 5 years of learning experience in filmmaking	Familiar with AI practices and has tried various AI tools in Filmmaking
IntS-5	University student and filmmaking graduate	Has 4 years of learning experience in filmmaking	Familiar with AI practices but limited to text generation AI
IntS-6	University student majoring in directing animation	Has 2 years of learning experience in directing animation	No experience with AI
IntS-7	Pre-master's degree student majoring in filmmaking	Has 7 years of learning experience in filmmaking	Tried AI in several aspects of Filmmaking
IntS-8	University student majoring in filmmaking	Has 4 years of learning experience in filmmaking	Familiar with AI practices but limited to text generation AI

3.5. Second-Round Interviews: Filmmaking Students

The second round of interviews involved eight students who were in the process of or had just received a higher education degree in filmmaking. These interviews aimed to capture each student's viewpoint on their learning journey, the relevance of current courses, and their perceptions of AI's potential impact on their education and future career.

3.6. Data Analysis

We also used a variety of data collection methods, including qualitative methods, such as the insights of the experts and students in the in-depth interviews, and quantitative methods, such as their ratings of the AI's recommendations for the different stages of filmmaking, in order to gain a more comprehensive understanding of the research questions.

The collected interview data underwent a rigorous qualitative analysis. A thematic analysis was employed to identify recurring patterns, key insights, and overarching themes. This process involved the following steps:

- Data familiarization: transcriptions of the interviews were reviewed multiple times for the researchers to become immersed in the data;
- Initial coding: meaningful segments of data were assigned initial codes, capturing key ideas and concepts;
- Theme generation: the codes were grouped into potential themes based on shared concepts or sentiments;
- Theme refinement: the themes were refined through continuous review, ensuring that they accurately represented the data;
- Theme clustering: the themes were clustered to generate comprehensive insights and meaningful patterns.

3.7. Ethical Considerations

The interviews conducted in this research adhered to strict ethical considerations to ensure the well-being and privacy of the participants. All participants, including the experts and students, provided informed consent which outlined the purpose, procedures, and voluntary nature of their participation in the study. They were assured of their anonymity, and their identities remained confidential throughout the research process. All collected data were assigned unique identifiers instead of using the participants' names. Any personal information shared during interviews was anonymized in the recording process. Only the research team had access to the raw data, which were securely stored on password-protected devices in compliance with data protection regulations.

Participation in the interviews was entirely voluntary, and the participants were informed that they could withdraw from the study at any time without any consequences. Great care was taken to ensure that the interviews did not cause any psychological, emotional, or professional harm to the participants. During the informed consent process, the potential benefits of participating in the research, such as contributing to advancements in design education and insights into AI integration, were emphasized. Transparency was maintained throughout the research process, with the participants informed about the research objectives, methods, and potential outcomes.

4. Results

This chapter presents the outcomes derived from the dual rounds of interviews featuring both industry experts and filmmaking students. The culmination of these discussions was encapsulated within User Journey Maps (Figures 6 and 7). Although the universities selected in this study differed in naming the core courses for the three stages of filmmaking, in general, the course content was similar. More than half of the experts and students who participated in the interviews in this study were from China, so we used the courses from the universities in China as references for the real courses in the Journey Maps. The User Journey Map served as a compelling visual aid that effectively depicted the participants' narratives and provided the participants' perspectives on incorporating AI recommendations into filmmaking education in an intuitive manner.

4.1. User Journey Maps: Experts

The User Journey Map, created for industry experts, is a canvas for comparing existing courses with those recommended by the AI. The map not only highlights differences but also reveals "Wow points"—areas in which the experts were interested in the potential of AI—and "Pain points"—areas in which concerns or skepticism arose. Moreover, this map showcases the experts' feedback on the recommended AI-integrated curriculum and their quantitative evaluation of these recommendations, spanning from -2 to 2. The User Journey Map unfolds as in Figure 6.

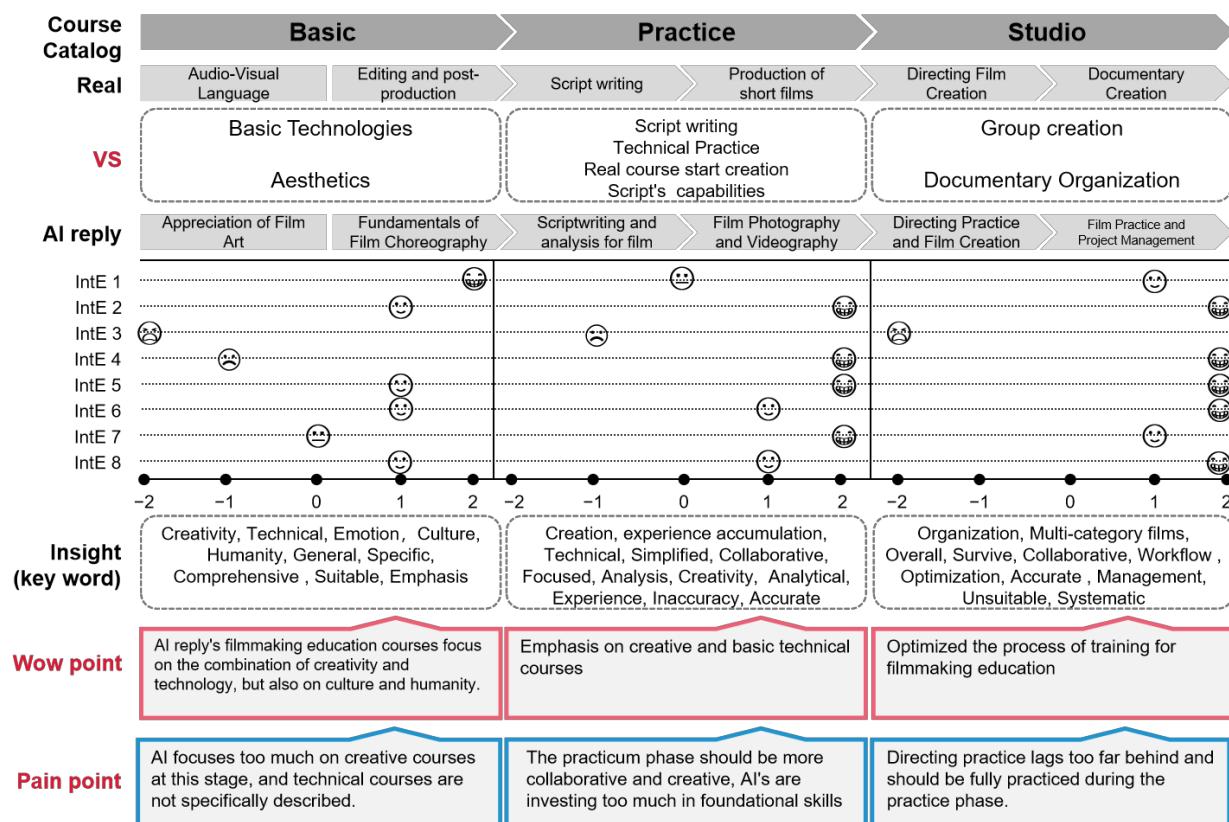


Figure 6. Journey Map 1: experts.

4.2. The User Journey Maps: Filmmaking Students

The User Journey Map for students depicts their educational journeys while interweaving their perceptions of real courses and AI-recommended courses. The map also encapsulates the “Wow points” and “Pain points” expressed by the students regarding the recommendations from the AI. The User Journey Map is shown in Figure 7.

4.3. Comparative Analysis

By comparing the Journey Maps of the industry experts and students, this section reveals shared viewpoints and discrepancies. It delves into points of agreement and divergence, shedding light on the perceptions and reservations concerning the integration of AI within filmmaking education. By juxtaposing the “Wow points” and “Pain points” articulated by both the experts and the students in the context of integrating artificial intelligence (AI) into filmmaking education, a nuanced understanding of their perceptions regarding AI’s role in education can be gained. The analysis highlights both shared perspectives and notable divergences, shedding light on the underlying factors influencing these viewpoints.

Common Perspectives:

Both the experts and students hold a shared appreciation for the emphasis on creativity and technical skills within the AI-generated recommendations for filmmaking education. This commonality reflects a recognition of the foundational role these competencies play in the education and practice of filmmaking. The consensus on the importance of fostering a balance between creativity and technicality underscores the intrinsic link between artistic innovation and technical proficiency in filmmaking.

Divergent Perspectives and Their Reasons:

1. The Integration of Culture and Humanity

Experts' Wow Point: The experts lauded the AI's proposition to integrate culture and humanity within filmmaking education. This acknowledgment signifies a comprehensive approach that aligns education with broader societal and cultural contexts.

Students' Wow Point: While the students also emphasized creativity, their focus was more on creative development within filmmaking itself.

Reasons for Divergence: the discrepancy in emphasis could be attributed to the experts' holistic perspective, considering the profound impact of culture and humanity on the storytelling aspect of filmmaking. In contrast, students may prioritize immediate practicality and creative exploration within the filmmaking process.

2. Technical Course Insufficiency

Experts' Pain Point: The lack of emphasis on technical courses was identified as a limitation of the AI-generated recommendations.

Students' Pain Point: the students echoed the experts' concern about inadequate technical coverage in the basic stage.

Reasons for Divergence: Both the experts and the students recognized the significance of technical skills; however, the experts seem to perceive the deficiency as a limitation in addressing the industry's comprehensive needs. Students, as the recipients of the education, may feel the impact of technical course insufficiency more acutely in their learning journey.

3. Timeliness and Real-World Relevance

Experts' Pain Point: The lag in directing practice caused the experts to worry about whether students would be able to accomplish the goals of the studio stage.

Students' Pain Point: The students cited concern regarding the AI's lag in project practice courses.

Reasons for Divergence: The students' concerns about timeliness and relevance likely stem from their immediate need for up-to-date knowledge and skills to succeed in the rapidly evolving filmmaking landscape. The appreciation for career-related courses implies a proactive stance toward aligning education with practical employment outcomes. From a professional perspective, the experts worried that the lag in directing practices would undermine the students' success in the studio stage.

In conclusion, while the experts and students share a collective appreciation for the AI's emphasis on creativity and technical skills in filmmaking education, their differing emphases on cultural integration, technical course coverage, and real-world relevance reflect their distinct perspectives and priorities. The experts' holistic view considers the broader sociocultural context, while the students' concerns revolve around immediate practicality and real-world application. Recognizing these shared and divergent viewpoints is crucial for effectively integrating AI into filmmaking education to cater to both the industry's demands and students' needs.

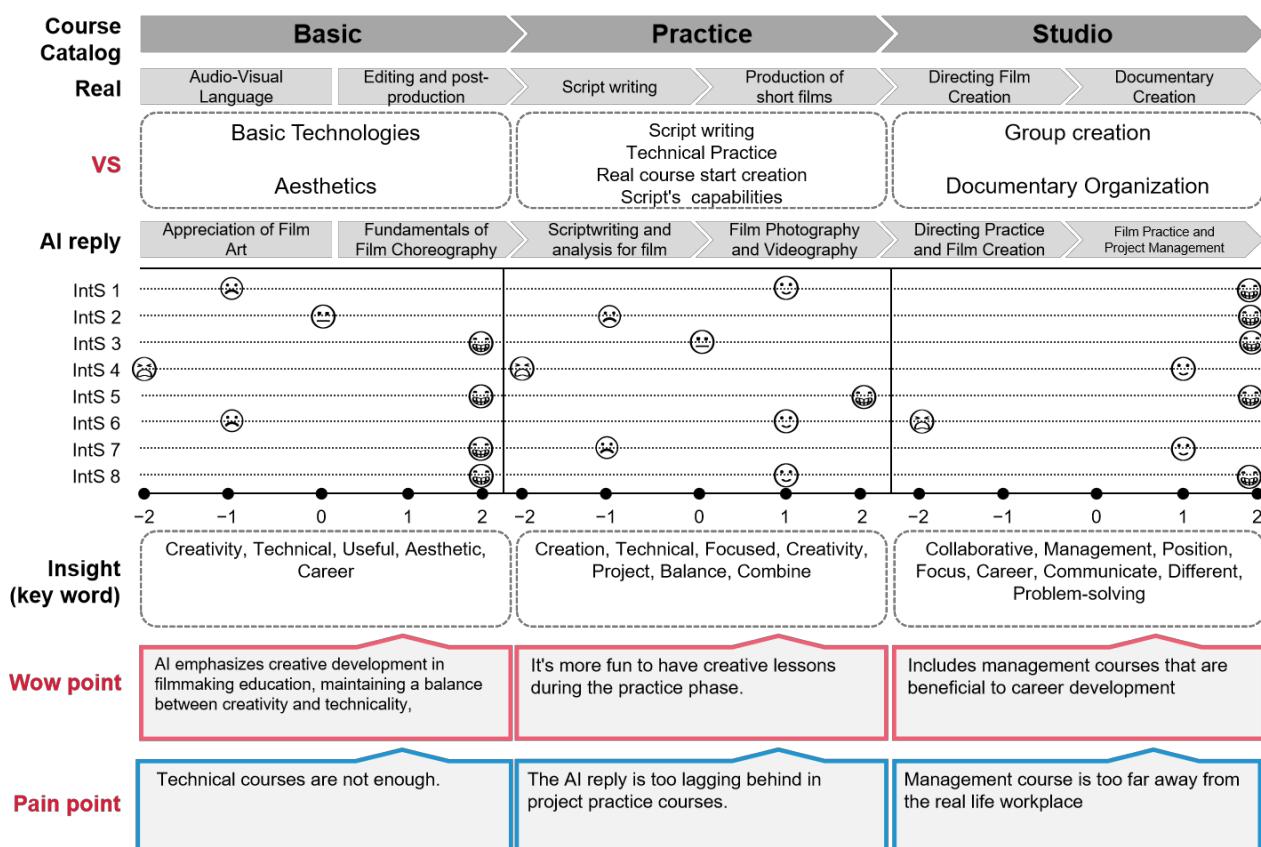


Figure 7. Journey Map 2: students.

5. Discussion

In this chapter, we engage in an exhaustive exploration and explication of the insights garnered from the interviews and User Journey Maps, aiming to contextualize the research findings within the domain of filmmaking education and the broader landscape of the integration of AI tools. Through a revisit of our research objectives, we gauge the extent to which they were accomplished through this comprehensive investigation. Our study employed a meticulous interview methodology to delve into the application of AI tools in curriculum planning from the vantage points of both industry experts and students in the filmmaking domain. By dissecting the collated interview data, we attain a more profound understanding of the challenges faced in filmmaking education and avenues for potential remedies.

5.1. Findings

Through this research effort, we embarked on a journey to explore the integration of AI tools into filmmaking education. Our research unfolded through careful examination, including interviews with experts and students, the creation of User Journey Maps, and a comparative analysis of their perspectives. Of the eight experts interviewed, seven had a positive view of the use of AI tools in filmmaking education, while one had a negative view. According to the experts, the AI's focus AI on creativity and technicality in filmmaking education, as well as the integration of humanity and culture, optimizes the process of filmmaking education to a certain extent. However, the programs created by the AI neglect the accumulation of practical experience, and the proportion of technical courses is small. In the interviews with eight students, six were positive about the use of AI tools in filmmaking education, while two were negative. They believed that AI emphasized the importance of creative development in filmmaking while maintaining a balance between

creativity and technology and that the AI-recommended project management courses were closely related to their later careers. However, the AI's recommendations lagged too far behind in terms of project practice, and the technical courses were insufficient; the project management courses recommended by the AI differed significantly in detail from those in real-world environments. In the interviews, both the experts and the students were positive about the use of AI tools in filmmaking education, with entry points focusing on the balance between creativity and technology, and negative about aspects such as the accumulation of practical experience. Our findings reveal a multifaceted dynamic between AI and filmmaking education, highlighting both common and divergent perspectives. In filmmaking education, the curriculum is critical for developing students' creative, technical, and collaborative skills. However, the rapid evolution of the industry and the diverse needs of students complicate the design and adaptation of curricula. Through interview data, we gained insights from experts and students that reveal the limitations of existing curricula as well as the potential of AI to provide more timeliness and forward-thinking curricular recommendations. Overall, the experts and students identified a positive efficiency in the AI's recommendations for filmmaking education, and they all agreed that AI really helps in filmmaking education. These data provide us with insights into the gaps in the existing education system. The survey helped identify the potential benefits and challenges that arise when AI intersects with the creative fields of filmmaking education.

5.2. Theoretical and Practical Implications

When comparing our results to the existing literature, we found points of commonality and points of deviation [65]. Our research not only resonates with this sentiment but also delves into specific applications of AI in filmmaking education. This sets our work apart as we explore uncharted territory by scrutinizing how AI tools impact curriculum design and student learning experiences [66]. However, this approach may not adequately account for the latest demands of the industry and the diverse needs of students. By analyzing the interview data, we can identify AI's to provide more accurate and current curriculum recommendations such as the project management course recommended by AI in this interview, which was positively endorsed by several experts and students and which fills a gap in the existing curriculum and enables education to better meet the needs of the industry and students [67].

5.3. Limitation

While our study offers some insights, we recognize that certain limitations merit discussion. In our study, we paid close attention to and attempted to minimize the effects of selection bias by selecting participants from as many different geographic locations and with as many different cultural backgrounds and educational experiences as possible and by using random sampling to send invitation emails to potential participants. Our participants, while carefully selected, may not include the full range of perspectives from experts and students in the field of filmmaking education. In addition, the rapid development of AI technology introduces complexities that could not be fully incorporated into the scope of this study. For example, ChatGPT, the large language AI model used in this study, was upgraded from ChatGPT3.5 to chatgpt4.0 during the study period. This necessitates ongoing engagement with international AI experts, educators, and professionals in the film industry to remain highly attuned to relevant developments in the field. This is crucial to ensure that curriculum design and development continue to stay at the forefront in an ever-evolving technological landscape. We also recognize that the introduction of AI education is not without its challenges. The balance from technical feasibility to the humanistic aspects of education needs to be explored and researched in greater depth. The use of AI in education will involve a range of moral and ethical issues [68]. Since AI may be used in cheating or plagiarism, threatening the fairness of online exams and quizzes, educators and related organizations must be aware of the lack of fairness resulting from the use of AI. In addition, advanced plagiarism-detection tools may be effective for cheating using

AI [69]. A heavy reliance on AI tools may have a negative impact on education and research. Educators need to carefully consider the impact of AI-recommended curricula on student creativity and critical thinking [70]. It is important to be aware of the limitations when using AI tools and that these tools should only be used as aids to enhance learning and research. At the same time, data privacy and algorithmic bias need to be given sufficient attention [71]. Large language models such as ChatGPT are significantly influenced by training data, which may generate algorithmic bias when the training data contain bias. If these data contain sensitive information, there is a risk of privacy leakage, requiring developers and researchers to strengthen data privacy protection. Also, users need to be cautious when using these models and avoid sharing sensitive information, especially when using large language models in untrusted environments. Regulations and standards in technology ethics and privacy protection are also evolving to ensure people's privacy and security when using these technologies.

6. Conclusions

This study explored the integration of AI tools into curriculum design within the realm of filmmaking education. Through a comprehensive research process, including desk research, expert and student interviews, and the creation of User Journey Maps, we uncovered the potential of artificial intelligence to enhance filmmaking education. Our investigation provides insights into the intricate interplay between traditional filmmaking education and cutting-edge AI technology, yielding valuable insights. The User Journey Maps vividly illustrate the disparities between existing curricula and AI-recommended modules. These disparities not only reveal gaps in current educational methodologies but also indicate AI's ability to propose alternative learning trajectories. With the help of artificial intelligence, experts and students show positive efficiency in filmmaking education.

Engaging with experts and students enabled us to assess the reception of AI-driven course recommendations. Expert feedback offered multifaceted viewpoints, acknowledging the potential of AI while recognizing the irreplaceable role of human expertise. Conversely, the students' interactions with AI's innovations and their aspirations for a balanced, human-centered learning approach intertwine. Integrating AI tools into filmmaking education will result in an up-to-date and dynamic learning experience. However, cautious steps must be taken, considering ethical dimensions and potential pitfalls. Responsible AI usage characterized by transparency, fairness, and accountability should guide the implementation of AI-driven educational strategies.

As we conclude this research, we acknowledge that our exploration merely scratches the surface of the profound transformations AI can bring to filmmaking education. The synergy between human creativity and AI's analytical capabilities is pivotal in shaping a new era of learning. This journey underscores the significance of effective guidance from educators, technologists, and visionary thinkers in advancing education.

Fundamentally, this study acts as a catalyst for further delving into the role of AI in education. Our findings call for collective dialogues among educators, educated peoples, decision makers, and researchers to harness the potential of artificial intelligence while preserving the essence of human-centric education. As we stand on the cusp of an AI-driven educational revolution, let this study serve as a beacon for exploring the uncharted waters of a transformed educational landscape.

Looking ahead, the integration of AI with filmmaking education remains a dynamic area for further exploration. The future of filmmaking will increasingly involve interdisciplinary collaboration and innovation [72]. AI not only has applications in filmmaking itself but can also drive the integration of filmmaking into other fields. For example, collaborations with computer science, data analytics, and virtual reality may lead to more creative and technologically in-depth films [73]. The introduction of AI may reshape the traditional paradigm of education. Educators will move beyond being simply transmitters of knowledge and become more mentors and partners [74]. AI may also provide data support between educators and students, helping educators to better understand the progress

and needs of students so that they can better tailor curricula and teaching methods [75]. If we change the parameters of our research, new questions will arise. For example, how will expert and student preferences and perceptions evolve as AI technologies evolve? How can we strike a delicate balance between AI-driven advice and upholding the values of humanistic education? Also, as the filmmaking industry continues to grow, how can AI-enhanced education align with industry needs?

In the quest for knowledge, this study lays the foundation for future research. We will further delve into the implementation of AI-recommended courses in filmmaking education, tracking their impact on student learning outcomes and the evolving demands of the film industry. We will continue to explore the practical application of AI tools in a specific course within a filmmaking program, investigating the key factors influencing the students taking this course and how the AI interacts with these key factors to produce a positive benefit that aligns better with educational objectives. We envision an ongoing dialogue among educators, students, and AI experts, shaping the landscape of filmmaking education and ushering in an era of creative and technological harmony.

In summary, this study reveals the potential of AI tools to revolutionize the field of filmmaking education. By revealing shared perspectives and differences, we contribute to the ongoing discussion about the convergence of technology and creativity. As AI progresses, we hope that this study will serve as a stepping stone toward a more holistic, personalized, and innovative approach to education in the field of filmmaking.

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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and approved by the Institutional Review Board of Kookmin University Institutional Review Board : KMUIRB (protocol code KUM-202311-HR-381 and date of approval was 14 November 2023).

Data Availability Statement: Data are contained within the article.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A. Interview Guide (Experts)

These questions were for reference only, with follow-up questions and in-depth discussions based on each expert's answers. At the same time, in order to ensure the flow of the interview, the order and content of the questions were flexibly adjusted according to the interview situation.

Background and Introduction

1. Can you briefly describe your background and your experience in filmmaking education?

Curriculum and Objectives

2. In your experience, what are the characteristics of the curriculum in the three phases of filmmaking education: basic, practice and studio?
3. This is the information on the curriculum of filmmaking majors in comprehensive universities in China, the United States, and Europe collected in our desk research for this study, what do you think about these curriculums?
4. This is information about AI's recommended curriculum for filmmaking education, how do you think AI's recommendations compare to the real curriculum?
5. What aspects of a filmmaking curriculum are most important to develop in students? (e.g., creativity, technique, practical experience, etc.)
6. What is the importance of the balance between creativity and technology for student development in filmmaking education?

7. What are some of the issues students may have with the actual film production project management course?
The use of AI in filmmaking education
8. What are your thoughts on the use of AI in filmmaking education?
9. What value do you think AI can provide to filmmaking education?
10. What kind of challenges may filmmaking education face when integrating AI in the future?
Interview Guide (Students)
Background and Introduction
 1. Briefly describe your background and your learning experience in filmmaking?

Curriculum and Objectives

 2. This is the curriculum information of filmmaking education in comprehensive universities in China, the United States, and Europe collected in our desk research for this study. How are these curriculums in your study experience?
 3. This is information about AI's recommended course curriculum for filmmaking, how do you feel about AI's recommendations compared to the real curriculum?
 4. What aspects of the filmmaking curriculum do you think are most important to your development? (e.g., creativity, technology, hands-on experience, etc.)
 5. In the study of filmmaking, which do you think you prefer between creativity and technology?
 6. Do you have a course like Project Management for Filmmaking in your program? If so, what problems did you encounter while taking it?

The use of AI in filmmaking education

 7. What are your thoughts on the use of AI in filmmaking education?
 8. Does AI's recommendation match your learning interests and direction?
 9. You've heard in previous interviews what experts think about AI in filmmaking education. Do you share any of these views? Are there some aspects that you have a different view on?

Appendix B. Some of the textual content of the interaction with ChatGPT (Figure 4)

ME:

This is the desk research study we did, it is the subject curriculum of the filmmaking majors in the university in three stages of courses: basic, practice and studio (China; basic stage: Directing Language and Technique, Editing and post-production; practice stage: Script writing, Production of short films; studio stage: Directing Film Creation, Documentary Creation; USA; basic stage: Photography and Imaging, Cinematic Creation; studio stage: Directing Film Creation, Documentary Creation; and studio stage: Photography and Imaging, Cinematic Creation. Writing, Production of short films; Studio stage: Directing Film Creation, Documentary Creation; USA; Foundation stage: Photography and Imaging, Cinematic Communication; Practicum in Cinematography, The Production and Post-Production; Studio: Cinematic Arts Laboratory, Advanced Production Workshop. Workshop; Europe; Foundation Stage: Digital Creativity and Content Creativity, Screen Performance; Practicum Stage: scripting for Screen, Production of short films; Studio Stage: (Collaborative Group Projects, Industrial Research Projects). How would you like to improve the three stages of the curriculum?

CHATGPT:

It appears you are seeking suggestions to improve the three stages of the curriculum for filmmaking majors in universities based on your desk research findings. Here's a breakdown of potential improvements for each stage:

Basic Stage:

Appreciation of Film Art: Consider including a course that focuses on the history and evolution of cinema, helping students gain a deeper understanding of the medium's artistic aspects.

Fundamentals of Film Choreography: Introduce a course that covers the basics of film choreography and composition, which are crucial for creating visually compelling content. Practice Stage:

Scriptwriting and Analysis for Film: Expand the scriptwriting course to include in-depth analysis of film scripts from different genres and eras. This will help students develop a more critical and analytical approach to screenwriting.

Film Photography and Videography: Combine photography and videography into a comprehensive course that covers both still and moving images. This integration can provide a more holistic understanding of visual storytelling.

Studio Stage:

Directing Practice and Film Creation: In the directing practice course, emphasize hands-on experience in directing short films. Provide students with opportunities to apply their skills in real-world filmmaking projects.

Film Practice and Project Management: Introduce a course that not only focuses on filmmaking techniques but also on project management skills. This course can prepare students for the practical aspects of working in the film industry, including budgeting, scheduling, and team management.

These improvements aim to enhance the overall curriculum by offering a more balanced and comprehensive education in filmmaking. They provide students with a solid foundation in film theory and practice while preparing them for the challenges of the film industry.

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Revolutionizing animation: unleashing the power of artificial intelligence for cutting-edge visual effects in films

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Focusing on
Animation

Abstract

Integrating artificial intelligence (AI) technology with the cinema and television sectors has resulted in significant transformations in the programming and production of television shows and the emergence of a novel cohort of AI-driven media. The ubiquity of AI-enabled technology enhances film and television production quality. Conversely, there has been a notable expansion in the animation sector in recent years, characterized by a growing number of film productions annually. Finding the user's preferred animated films within the large array of information about animated movies has emerged as a notable obstacle. This article examines the sophisticated visual effects of computer vision in animated films, focusing on using artificial intelligence and machine learning technologies. This article proposes a critical perspective on fostering the advancement of cinematic visual effects through strategic means, utilizing computer vision and machine learning technology as fundamental tools for investigating novel methodologies and frameworks for achieving visual effects. This article explores new methodologies and methods for creating visual effects in moving images, using the film industry's digitalization, intelligent advancement, and enhancement as a starting point. This article examines the application of convolutional neural algorithms in analyzing the visual effects of the Hollywood anime film "Coco." The study's findings indicate that the test set's accuracy remained relatively constant at approximately 59% even after determining the model's parameters. This outcome significantly enhances film productions' audiovisual quality and creative standards while fostering healthy and sustainable growth in the film industry.

Keywords Animation movies · Visual effects · Artificial intelligence · Machine learning · Computer vision

1 Introduction

Computer animation has experienced rapid growth and emerged as a prominent form of multimedia expression in contemporary times (Zhao et al. 2022). The ubiquitous availability of computers and digital information resources has significantly contributed to this accomplishment. The significance of animation, character modelling, and painting is paramount in computer animation technology. Incorporating complexity in character design aims to

enhance the visual representation of animated figures and augment the overall impact of animation. According to the second source (Garmeh et al. 2020), the objective of this study is to enhance the visual representation of animated characters. Pursuing a dependable methodology for creating painted and modelled animation figures has emerged as the central area of investigation for animation designers and scholars in academia. As the economy expands, individuals' aspirations regarding their purchasing power and the level of enjoyment they can derive from it also increase. The contemporary animation sector within the new media realm encounters specific pervasive challenges, evident in its artistic ingenuity and visual appeal. Special effects and colors in animation play a pivotal role as a symbolic language for conveying information, with each element making a distinct contribution to the overall impact.

Special effects

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There has been a notable increase in the prevalence of performances that integrate various visual languages to create a distinctive and unified entity. With the continuous expansion of digital media production and consumption capacities, there is an increasing trend toward creating hybrid images. New media's development and quick growth in recent years have increased the prevalence of special effects and graphic color mixing. This phenomenon is gaining traction in contemporary visual communication design, broadening its application area and becoming more extensive. This phenomenon might be attributed to new media's introduction and rapid development in recent years. The animation in the previous images was generated using a combination of simple color schemes and geometric forms. Nevertheless, this approach is pervasive and extensively utilized. This phenomenon presents a challenge in envisioning innovative visual manifestations of emotional states. Regardless, contemporary visuals and graphics are derived from synthesizing both elements, thus augmenting each other. Presently, there is a proliferation of innovative visual encounters.

The visual execution of films has long been a perennial topic of controversy within cinema. The interconnection between it and the advancement of civilization, the expansion of commerce, and the implementation of state-of-the-art technologies is undeniable (Ma et al. 2019). This paper presents a comprehensive analysis of the process of film conception, highlighting its persuasive, organic, and efficient nature. To enhance the overall understanding and appreciation of cinematic works, it is imperative to effectively portray the emotions and experiences of film characters using visual elements (Alkasassbeh 2017). The topic of discussion pertains to cameras. To consistently enhance the visual impact of cinematic works, the optical performance of cinema must align with contemporary standards (Johnson et al. 2018; Prakash et al. 2018). This phenomenon is concurrent with the escalating process of information technology and overall societal intelligence advancement. Therefore, it is imperative to assess the visual efficacy of cinema, explore novel approaches to enhance it and adapt to evolving cultural norms and commercial requirements (Dyster et al. 2016; Foulquier et al. 2018). Publications, including newspapers and magazines, emerged as the earliest manifestations of what would later be recognized as visual media. Visual designers must consistently consider the various mediums via which their work is disseminated. The intricate interplay is between the designer and the observer and the efficacy of information transmission (Yuan et al. 2016). The term "new visual media" pertains to a contemporary cohort of media that has experienced a surge in popularity and widespread acceptance among the general populace. During the initial surge in popularity of captivating visual effects and other design

elements, designers were compelled to adjust their approach to cater to the increasing consumer demand. This adjustment involved integrating additional sensory experiences into their creative endeavors. Research suggests individuals are more inclined to collaborate and exchange ideas when motivated to experience similar emotions (Zhou et al. 2017; Baquero-Pecino 2016). The emergence of interactive media, such as the internet, has significantly expanded the potential of traditional visual media. When an entity is expected to produce an impact, it fails (Valente et al. 2018; Borowski et al. 2008). This phenomenon occurs due to the inherent variability in individuals' interpretations of information or expressions of emotion. The visual designer, after that, initiated contemplation on strategies to maximize audience empathy. The optimal appreciation of the work cannot be achieved unless there is a shared understanding between the audience and the designer (Chen et al. 2016).

Visual artists serve as the public representatives of designers, possessing extensive expertise in several disciplines, such as technology and psychology. Visual artists operate within the design sector and engage directly with the general audience. The inherent emergence of delight, imagination, comprehension, discovery, and research within the artistic process facilitates the enhancement of creative conceptions' authenticity (Bloch 2015; Pradhan et al. 2016). The recipient plays a pivotal and occasionally indispensable role in transmitting the message. Artificial intelligence (AI) endeavors to endow robots with comparable intelligence to humans to achieve the same capabilities humans have historically exhibited. Using prediction models based on artificial intelligence has much potential for solving complex environmental problems with many variables that do not seem connected and have tough, nonlinear relationships. Energy engineering modelling tools based on artificial intelligence (AI) have recently been used to simulate various realistic processes (Bennis et al. 2017). The techniques encompassed in this category consist of artificial neural networks, fuzzy logic, and adaptive neural fuzzy inference systems. The conclusion above is derived from the principles of determinism and the nonlinearity inherent in artificial intelligence.

This paper aims to provide the reader with a comprehensive understanding of the mathematical foundations behind two widely utilized artificial intelligence technologies: artificial neural networks and support vector machines. The text examines various approaches' computational difficulties and advantages and highlights the availability of several model implementations in online software repositories (Zhou et al. 2019). Deep learning has demonstrated significant promise in several artificial intelligence applications in recent years. Illustrating this point, Google Translate is a viable consideration.

Therefore, it was imperative to assess the efficacy of a deep learning framework known as a deep neural network (DNN) in the context of malware classification compared to a conventional machine learning approach referred to as random forests (RF). The researchers discovered that traditional random forests (RF) exhibited superior accuracy compared to deep neural networks (DNNs) with two, four, and seven layers, as demonstrated by the analysis of four separate feature sets (Dyster et al. 2016). There is a growing interest within both the academic and corporate worlds in researching artificial intelligence. This phenomenon has sparked a heightened curiosity in investigating the potential for artificial intelligence (AI) to surpass human judgment in critical decision-making. It is widely acknowledged that making accurate predictions regarding the outcome of a sporting event is challenging due to the numerous variables involved. The inherent limitations of human decision-making processes render it unfeasible to generate objective predictions, resulting in the inevitable influence of bias in any such endeavor.

Artificial intelligence techniques, particularly machine learning, are expected to yield substantial enhancements in precision. Random forest classification methodology generates predictions regarding the 2015 Rugby World Cup outcomes. Super Bru and Odd-Portal, two others extensively employed techniques for this objective, are subjected to a comparative analysis with our model's outcomes. The accuracy of machine-learning-based systems is estimated to lie within a 95% confidence interval ranging from 77.83% to 95.47%. Within this interval, the estimated accuracy ranges from 89.58% to 85.58%. Additionally, the accuracy of these systems is estimated to have a 95% confidence interval ranging from 77.83% to 92.75%, with an estimated accuracy of 85.42%. The range of values is from 72.83 to 92.75. Based on the obtained results, it is impossible to establish a definitive conclusion that human agents exhibit superior accuracy compared to machine learning methods in forecasting the outcomes of rugby games, with a significance level of 0.05. This statement holds for a specified period during a singular instance of gameplay. Nevertheless, the model demonstrates superior performance compared to both platforms regarding its ability to estimate the odds of winning rounds based on currency bets (Zhao et al. 2022). The term "machine learning" (ML) has gained significant prominence in contemporary discourse. To develop machine learning applications, one can employ conventional software engineering methodologies. Nevertheless, it is imperative to consider the distinctive challenges of machine learning applications concerning quality standards.

Given the growing prominence of the subject matter, a group of researchers decided to survey the software quality of machine learning (ML) applications. This poll facilitated

the identification of challenges affecting machine learning applications and the identification of potential research avenues in software engineering and software testing, which could contribute to their resolution. The study's objectives were categorized into three distinct divisions: academic conferences, scholarly journals, and internet communities. The machine learning techniques are utilized for data aggregation in collecting sensor information. Various machine learning approaches, such as a neural network, a genetic algorithm, and an adaptive neural fuzzy inference system, have been successfully implemented using the MATLAB programming environment. The researchers subsequently analyzed and compared the model's accuracy and robustness to the mean squared error (MSE). The findings of this study indicate that process models constructed through machine learning techniques exhibit higher accuracy, resilience, and adaptability to updates based on new data compared to models produced using traditional methods. The available evidence unequivocally substantiates this verdict. Utilizing machine learning algorithms presents significant benefits and a wide range of potential applications in industrial operations (Raedt et al. 2016). This article begins by examining the integration of computer vision and machine learning as a starting point for investigating novel approaches and models for producing visual effects (VFX) within the film industry. Additionally, it provides valuable strategic considerations to foster the innovative evolution of the graphical expression medium in filmmaking. This study investigates novel methodologies and frameworks for generating visual effects in the context of motion pictures, considering the film industry's digital transformation, intelligent advancements, and progress. Enhancing the technical and aesthetic aspects of films plays a pivotal role in ensuring the long-term prosperity and sustainability of the film industry. Additionally, it is imperative to nurture the industry's growth sustainably, conducive to its overall well-being.

2 Related work

Experts on the subject agree that "artificial intelligence" refers to the process of "training" computer systems to "act" like people and "complete" activities that people can only perform when using their brains. To be clear, this is not a definition of artificial intelligence. Get the operational aspects of the machine tested to the necessary degree. Academics are working hard to advance artificial intelligence and have produced substantial advancements in various fields. User modelling is made more accessible by reading (Azmat et al. 2016), and modelling technology development is informed by investigating the design space.

An animation image innovation design approach based on evolutionary computation has previously been created (Tao et al. 2016). This model's creation involved using the CGI image innovation design process. The components that enable component reconstruction, evolutionary design, component management, and autonomous assembly are only a few examples of primary system capabilities. It permits human alteration of models in a visual environment and automated manufacture and assembly of components. A user may take this action. Within a limited range, it has been demonstrated that 3D model simplification based on the detection of symmetrical features can increase model simplification efficiency (Clancy et al. 2016). Simplifying a three-dimensional model while maintaining attributes results in less memory consumption and less distortion. Additionally, the model can be altered to minimize the resources it uses. Its practical use is increasingly evident, particularly in simulation studies involving numerous models. *Drawbacks + Potential Sol's !?*

The issues of designing 3DsMax expressions with the current technology have been examined in the literature (Li et al. 2016). A 3dsMax-based method for character face emotion animation is then built after that. Based on studies into the principles and methods for designing expressive facial expressions for 3D computer-generated characters, the academic literature (Polizzi di Sorrentino et al. 2016; Yun et al. 2016) describes a method for de-complicating 3D models that depends on finding symmetrical features in the model. Here, three strategies—diversity modelling of 3D models, degree simplification, and the identification of proportional features—will be examined to increase the efficiency of 3D models' simplification in simulation applications, and by reading every available character, the author of the literature (Jian et al. 2020) created a database of animated characters. We can improve the modelled characters' engagement and shareability through user testing and feedback.

In the work cited at (Min et al. 2016), CAD and the concept of biological genetic evolution (BGE) are coupled to provide designers with a tool to help them combat the inclination toward slow thought. A technique described in the literature (Liu et al. 2016) and implemented in 3DsMax was used to produce a realistic facial emotion animation system. This technique was created considering how the muscles that control facial expression normally function. Literature (Metsch et al. 2019) emphasizes the importance of conducting experiments near humanoids to achieve the study's primary objective. Each piece can be reduced through classification and analysis, enabling them to perform various tasks. Animation production software is a sophisticated system that requires the input of computer scientists, artists, and producers from multiple other fields, according to the literature that is now available (Zhan et al.

2017). To design such software, these individuals must pool their skills. This is a necessity for serious computer animation work. In the published paper, the authors present a novel technique for creating 3D animation character visual effects and a deep neural network-based, intelligent CAD system for creating animated character images (Bignardi et al. 2016). These state-of-the-art techniques all use evolutionary computing techniques to provide unique animation graphics. All of these advancements (DNN) had a significant positive impact on animation image design. The new visual effects that recently debuted in animated movies as a result of advancements in AI and ML technologies will be discussed in this essay. (Han et al. 2017) This essay offers fresh perspectives on how to innovate VFX for movies strategically. The paper provides a framework for using computer vision and machine learning to investigate fresh methods and models for animating movie visual effects. This essay examines new methods for effectively using visual effects, using the current informatization, intelligent development, and upgrading in the film industry as a jumping-off point.

3 Proposed methodology

Consequently, the following technologies, which are enumerated below, will be seen:

3.1 Machine intelligence



The screening of movie scripts might employ artificial intelligence. AI algorithms have the potential to significantly streamline and speed up the process of script analysis by analyzing the storyline of the screenplay and presenting prospective questions, uncertainties, and ideas. Artificial intelligence is already widely used in the film business. Storyboarding, planning, scheduling, pre-production, box office performance forecasting, casting, and marketing are all made more accessible with its aid. The use of software for music production, coloring, and video editing is also expanding. The watching experience can be improved using AI for content personalization, packaging, and real-time delivery. Increasing ad sales is a positive outcome because it enables more exact placement of ads. Using alternatives to digital billboards during live sporting events can boost advertising revenue. The development of technology has directly contributed to growth in the media and entertainment sectors. This includes cutting-edge special effects created for movies (and utilized across multiple sectors), the emergence of streaming media, virtual reality gaming, and revolutionary distribution mechanisms for ads, music, and news. Several researchers are focusing their time and efforts on improving AI and have made several

advancements in this area that apply to other disciplines. Only a few industries have profited from AI technology: the medical, biological, geological, geophysical, aerospace, chemical, and electronic industries.

3.2 Artificial intelligence in Peril



Weak artificial intelligence (weak AI) is an approach to AI research that considers that AI is and always will mimic human cognitive function and that computers can only appear to think but are not truly aware of any meaning of the word. This artificial intelligence type, called “weak AI,” is fundamental. Weak AI cannot deviate from the standards placed upon it; it only responds and behaves according to those norms. Video game characters that act logically within the parameters of their game roles but cannot perform any other tasks are the best examples of weak artificial intelligence (AI). A weak or narrow AI system has a limited set of abilities. Using pre-programmed computer systems to simulate the logical reasoning of biological species like humans and animals is known as weak artificial intelligence (AI, for short). According to the rudimentary AI theory, building intelligent robots that can think or solve issues on par with humans is mathematically impossible. As a result, these machines would be unable to think or reason.

Weak org. but still could use.

3.3 Practical artificial intelligence

“Strong artificial intelligence,” also referred to as “artificial general intelligence” (AGI) or “generic AI,” is a theoretical category of AI that is used to express a specific way of thinking about the development of AI. Researchers must build a computer with human-level intelligence to develop beneficial artificial intelligence. With the capacity to reason independently, this artificial intelligence can solve problems, learn new things, and plan for the future. Robust AI research ultimately aims to develop AI systems equal to human intellect. However, for the artificial intelligence machine to continue growing and improving its skills over time, just like a child, it would need to learn from knowledge and experience. Although there are AI researchers at academic institutions and business companies invested in its development, artificial general intelligence (AGI) is still more of a theoretical idea than a practical reality. Some experts, such as Marvin Minsky, have come under fire for having an unduly optimistic view of what AI will be capable of in the ensuing decades. Some experts contend that creating systems with strong AI is not viable. Their point of view will be valid if the criteria for success, such as IQ and comprehension level, still need to be established. The Turing test is currently a popular tool for determining an artificial intelligence system’s level of

intelligence. One of the most sophisticated types of artificial intelligence is strong AI (often referred to as BOT-TOM-UPAI). It is conceivable to program a computer to have sentience, emotion, intellect, and problem-solving abilities, according to “strong AI” proponents.

3.4 Artificial intelligence applications

A convolutional neural network’s fundamental tasks of accepting an input image, extracting features from regions, computing features based on neural convolution, and categorizing objects in regions remain the same regardless of the network’s design changes. Incorporating feature extraction and classification methods is one of the most critical steps. The parameters of the fully connected layer and the convolution template are continuously optimized using back-propagation, a gradient descent technique. This enables the collection of the features required for classification and ensures that the classifiers and learned features will be as accurate as possible. In this study, platform construction, identification, and verification are carried out using a deep recursive convolutional neural network technique.

- i. To obtain features of important categories like people, animals, and vehicles, machine learning’s feature extraction process, also known as the simulation of human recognition of category features, uses image training datasets like the open-source MNIST dataset, ImageNet dataset, PASCAL VOC training set, COCO, and others (also known as “see more knowledge”).
- ii. To identify the best candidates, first identify prospective targets in the analysis video (multitarget objects are possible; in this case, Jean Agen is an example).
- iii. Using a deep recursive convolutional neural network called CAFFE, it is possible to identify and categorize the compositions, scenes, and conversations in movies. It is required to give the classifier category features and other information to satisfy the specific requirements of a movie object-matching categorization.
- iv. Film and video sequence and lens content semantic synthesis; film and video scene recognition and calibration.

AI Film ex.

Since a single movie can only hold so much information, the video is sometimes cut into numerous still images. Because of this, every visual frame contains a wealth of helpful information. The recursive convolutional neural network technique was used to accomplish quick, precise, and accurate recognition and retrieval of movie information. The LOSS function was modified to improve object

recognition accuracy, which made it possible to detect and position targets more accurately and quickly.

3.5 The different machine learning techniques

Learning is a highly complex knowledge action that is intricately tied to the act of inference. Many machine learning subfields exist, including learning strategies, information descriptions, and application areas. The machine learning system's algorithm will typically determine the best way to convey a person's experience. Students who exhibit this organizational style can be helpful in various settings. As a result, the basic types of machine learning based on the reasoning method will be briefly introduced in the next section. This could offer a more accurate depiction of learning, the learner's relationship to the process of knowledge modification, and how the learner gains from the outcomes.

3.6 Learning machines

Since experience rather than planned instructions is the basis for learning and adaptation, machine learning animation is a feature of AI applications. However, this differs from traditional animation, which adheres to rigorous rules. The functioning of the brain and the process of machine learning animation can be compared. Virtually every subject may be more fascinating by using animated learning resources, which can be used for various topics. As a result, teachers now have a new resource at their disposal: visual aids, which can be used to help explain multiple subjects. Additionally, it emphasizes doing rather than just hearing about things, which is a pleasant way to learn.

3.7 Supervised education

In the machine learning subfield known as "supervised learning," the data used to train the software are labelled according to a specific classification. Typically, machines are given training data and asked to forecast future outcomes using that data. A portion of the input has been tagged with the anticipated outcome when the data are labelled. The training data utilized in supervised learning serves as the "teacher," giving computers the information they need to make accurate predictions of future outcomes. It takes advantage of the same conceptual framework taught to a student under the guidance of a teacher. Supervised learning refers to training a machine learning model by providing it with both input and output data. An essential part of any managed learning method is discovering a mapping function that converts an input variable (x) into a target variable (y). Risk assessment, picture

categorization, fraud detection, and spam filtering are real-world uses for supervised learning.

3.8 Deductive learning

Deductive learning is a teaching strategy emphasizing the instructor's function. At first, students are exposed to overarching ideas and generalizations; later, they move on to more targeted instances and educational exercises. Most classes are taught with a teacher giving a monologue to the students. A computer can use this learning method to delve into areas of knowledge it has not yet encountered, expanding its repertoire of valuable data.

3.9 Inductive learning

In inductive learning, also known as discovery learning, the student learns by seeing examples and drawing conclusions about the underlying rules. It is in contrast with learning by deduction, in which students are given rules and asked to apply them in practice. Knowledge may be extracted in two essential ways: by talking to experts in the field or by employing machine learning. Experts in a specific field are of little use and should not be depended upon when working with a massive dataset. As a result, we will be considering this task from a machine-learning perspective. One strategy to apply machine learning involves emulating experts' thought processes by writing algorithms, which is time-consuming and costly.

3.10 Analogy learning

Students who want to learn how to draw analogies must be able to apply the underlying structure of familiar concepts to novel ones (Gentner 1983). Learning by analogy is especially helpful for novices in the field of athletics. A standard communication method is analogies, which include drawing parallels between two unrelated things for explanation. Like a box of chocolates, as the adage depicts, you never know what you will get in life. Your use of metaphors and similes in building a comparison is quite acceptable. An example of a metaphor is a simile. The value and efficacy of data connected to the target domain can be improved by collecting as much information as possible about the expertise present in the source domain. Gathering as much data as possible will help with this. A significant benefit of analogue learning is the capacity to immediately adapt a computer system successfully run in one field into an application for a field relatively similar to the first. One of the main benefits of analogue learning is that it reduces the amount of money spent on secondary development.

3.11 Explain learning

The purpose of an explanation learning environment is to show the student how the example achieves the concept of a given objective and to instruct them on the rules of interpretation included within the example. An example is provided to help them understand how this works. The term “explain learning” has been used to describe this teaching mode. This understanding can be extended to include the concept of the goal as long as the basic knowledge system is functional. Consider the following: to cite just one example, explaining that learning is widely adopted to rationalize the knowledge base and improve system performance.

3.12 Machine learning and the future of movies visual effects

VFX
using machine learning always.
Double check

AI is being applied to enhance VFX in movies. Algorithms that employ machine learning can be trained to identify and label the elements of a scene. Thanks to this, it is now a lot easier and faster to implement VFX features. The final step in machine learning entails adapting the training or learning model to use the newly available data. To sum up, generalization provides a potent tool for avoiding overfitting and underfitting. One such issue is overfitting, which arises when a model predicts known data too precisely but needs more learning power to predict unknown data accurately. As a result, the student’s capacity for generalization suffers. This is the biggest challenge facing machine learning today and must be conquered. The inability to learn can be traced back to insufficient training examples, which can be fixed by acquiring additional knowledge. A lack of learning can be traced back to a lack of study time. The method of mechanical learning has found widespread use in computer graphics, movie virtual asset analysis, and the growth of 3D animation. For instance, in 3D animated film production, the idea of recycling 3D motion data has lately emerged as a prominent topic of discussion. In recent years, this problem has been a hot topic for debate.

For data-driven movement to progress, this is the starting point. Mechanical learning technology can reuse 3D motion data from a massive amount of previously collected 3D motion and expression data by applying subspace analysis, statistical learning, principal component analysis, and multiple-body learning. Multiple-body learning is a valuable tool for achieving this goal. Using both sets of information will allow us to do this. Explore the topic, learn more, and oversee the collection of new movement data. Also, crucial to developing 3D animation films is the study of automating and intelligently generating action

animation. It is implemented by programming agents to make their own decisions and by designing and animating the movements of digital figures. It has applications in the field of machine learning technology, for instance, in the creation of a primary mode of behaviors. Establishing the virtual character’s action and consciousness mode allows for developing a dialogue-based virtual environment and implementing a dynamic action plan. The agent can rapidly and safely learn to converse with various people by establishing these channels.

Semi-supervised learning technology also contributes significantly to the rapidly growing industry of virtual movie production. Semi-supervised learning is a method in which students do not rely on the activities of their peers to improve their knowledge but rather use unlabeled data in an automated fashion. Directly driven learning and pure semi-supervised learning are two distinct approaches. The latter presupposes that the unlabeled samples used for evaluation throughout the learning process represent expected data and that the goal of the learning process is to achieve the best possible generalized performance concerning the unlabeled cases. Unlabeled samples are routinely collected while collecting and analyzing a film’s virtual assets. It takes a lot of effort and time to get labels printed. Using a mix of labelled and unlabeled samples helps develop more accurate data models, finish learning tasks, and reduce the time and effort spent labelling samples. The generated data model for semi-supervised learning is shown in Fig. 1. Through the three processes of perception, learning, and cognition, humans can piece together the fragments of information that make up the vast, mysterious world. However, study topics rely on human beings’ recognized nature and rules. These ideas also incorporate the unknowability of the human mind and the development of futuristic scientific knowledge.

4 Experimental study on animation films

4.1 Modelling process

Figures 2 and 3 show the primary aspects of modelling, which include the production of animation scenes, the development of animation models, and the development of animation props. Creating an animation starts with a model. Models used in film and television productions are often built using points, lines, and uniform spacing. Furthermore, the lines themselves must be parallel to one another. Moreover, the model’s scale should mirror that of the original. It is possible to obtain the required appearance by manipulating points, lines, and faces on the conventional model, allowing for the creation of even some extreme designs. The anatomical and physiological details

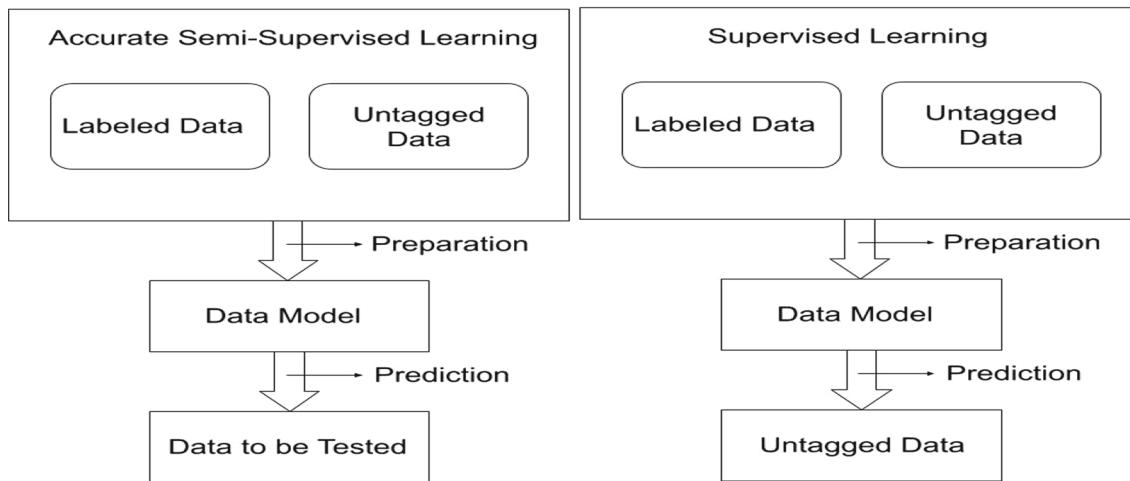


Fig. 1 Architecture of semi-supervised and supervised learning



Fig. 2 The process of making animation scenes

of the human or animal character model must be accurate. Correct proportions between the head, upper body, and lower body are essential. A human or animal's eyes, nose, ears, and mouth should be placed in natural locations and

have the appropriate size and proportion. When the model is complete, the next step is to divide up the components.

4.2 Animation

The animation must be done once all preceding tasks are finished. Many elements of an animated feature manufactured in the USA are open to revision. The model's location, the model's behaviors, the scene's lighting, and the scene's composition are all examples of these variables. When editing an animation, the animation's pace should reflect the animation object's speed. In the animated version, completing the transitions is accomplished in a quicker amount of time than would be required in real life. It is related to how quickly animations can be processed. This study employs a convolutional neural network

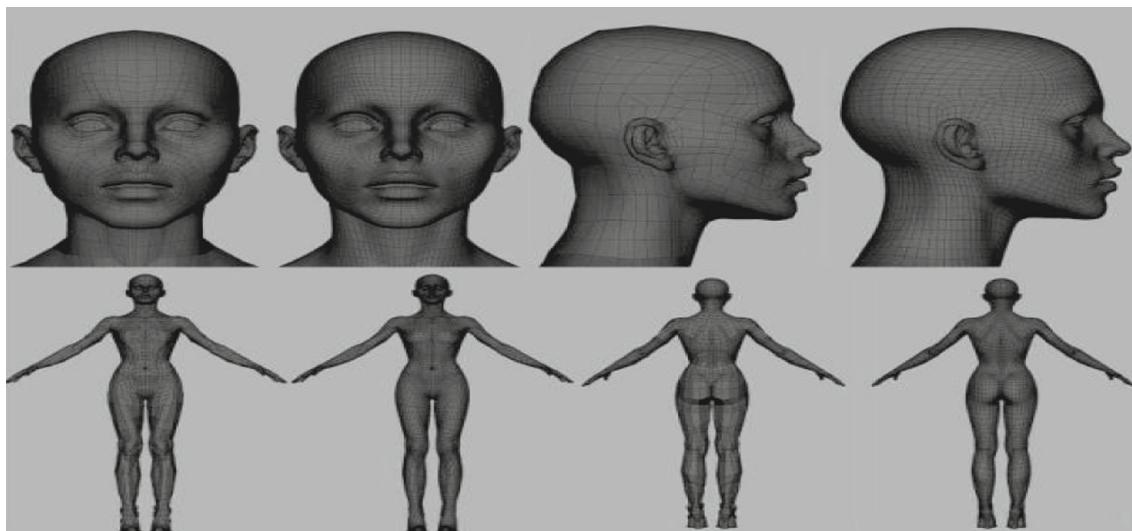


Fig. 3 Modelling in animation

strategy to analyze data related to the emerging field of computer vision in anime. The training strategy for convolutional neural networks relies on the idea that the network should be iteratively trained using gradient descent to minimize the loss function before feeding the results of the changes back up through the layers of the network. Find the optimal values for each layer's parameters so that the model closely matches the training data while keeping the weight offset in a consistent and in-sync optimized state. Such parameters can only be obtained by correctly modelling the training data. The steps of the convolutional neural network algorithm consist of the following procedures:

Algorithm: convolutional neural network

Step 1: Initialization of the Neural Network. // how many times to practice, how fast to learn, and what value to assign to the loss function //

Step 2: Produce a random initial value for the weights and offsets by utilizing a sequence of random numbers.

Step 3: Select n input data: $X(n) = (x_1(n), x_2(n), \dots, x_k(n))$ $D(n) = (d_1(n), d_2(n), \dots, d_q(n))$ // To train the model, randomly select n input and output pairs from the training set. //

Step 4: $F_{in}(n) = \sum_{i=1}^n (p_i, w_i + b_h)$ $F_{out}(n) = \text{Max}(0, F_{in}(n))$ // You may calculate the output by adding the information from each layer of neurons until you reach the one in the end. //

Step 5: Define error function:
 $\text{error} = \frac{1}{2} \sum_{o=1}^q (d_o(k) - f_{out}(n))^2$

Step 6: Weights and offsets should be constantly refined through iterative learning to ensure precision.

Step 7: Employ the error function to determine if the requirements have been met. The training is complete if the error value is within the allowed range or if the number of iterative training sessions hits a threshold.

Step 8: Continue with the training if this is not the case, continue to Step 3.

4.3 Selection of training data



The Movie Lens Movielens-100 K dataset was used for this research. This dataset contains 410,000 ratings for 1882 anime movies provided by 943 users. Dataset contents include user ID, age, occupation, gender, region, anime movie title, genre, and rating. As shown in Fig. 4, a set of feature vectors was gathered for analysis. Jobs need to be numerically represented for the convolutional neural network to utilize them as input data. In the paper, researchers randomly assign 21 occupations for analysis. After an initial value is set, it will be modified through a process of forward adjustment error that considers various occupational factors and the user's interest value

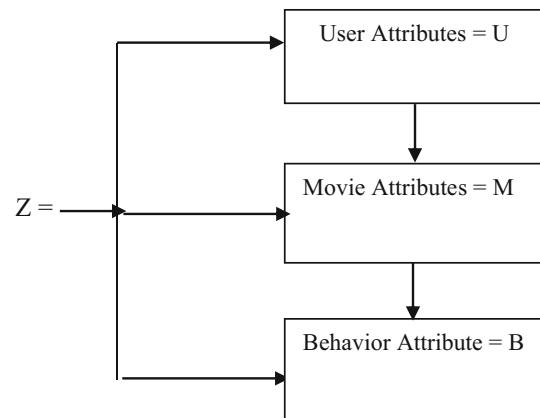


Fig. 4 Information based on feature vectors

proportion. After the first value has been established, this will occur.

4.4 K-fold cross-validation method

Cross-validation is a resampling technique to assess machine learning models with limited datasets. The process has a single parameter, k, which specifies how many groups the data will be split into. Thus, k-fold cross-validation has become a common name for this procedure. Cross-validation is a technique used in machine learning to assess how well a model can anticipate the outcomes of experiments based on hidden data. As can be seen in Fig. 5, it has gained popularity due to being easy to comprehend, producing solid results even with a tiny data sample, and offering an evaluation that is less prone to bias.

The term “K-fold cross-validation” describes this method since the data sample is split into a predetermined number of subsamples. Other phrases might include “fourfold cross-validation” and “tenfold cross-validation,” implying that the dataset is divided into four or ten smaller samples for more straightforward analysis. Choosing an appropriate value for k is crucial. A wrong estimate of the model’s efficacy is possible if k is chosen poorly. In other words, it can dramatically change the measured capabilities of the model or lead them to be significantly underestimated (high bias) depending on the training data used (high variance).

4.5 2K-fold cross-validation method

The 2 K-fold cross-validation technique, based on the K-fold technique, divides each subgroup in half. The training data are extracted from S0, and the tested data are removed from S1, with S0 and S1 referred to as S0 and S1, respectively. S0 is the training set, while S1 is the evaluation set. Set S1 will serve as the training set, while set S0

Fig. 5 K-fold cross-validation method



will be evaluated as the test set following the experiment. A benefit of the 2 K-fold cross-validation method is that both the test set and training set are large enough to undergo recurrent testing proportional to the number of samples. Compared to other methods, this method is preferable. As a matter of thumb, the parameter K is set to 10 when conducting a 2 K-fold cross-validation. Figure 6's five models were chosen to represent false negatives based on their aggregate mean accuracy.

5 Result analysis

*result for ideal
training model method*

5.1 Training analysis of convolutional neural network

A convolutional neural network (CNN) is a deep learning model trained to automatically and adaptively learn spatial hierarchies of features, starting with the most basic and progressing to the most complex. Based on the structure of the visual cortex in animals (Borowsky et al. 2008; Chen et al. 2016), CNN is optimized for processing input with a grid pattern, like images. This covers the number of iterations, the step size, the number of convolutional layers, the number of convolution kernels, the number of pooling

layers, and the number of convolutional layers. The size of the steps is also shown. Table 1 and Fig. 7 show the possible hyperparameter combinations for the convolutional neural network, along with the corresponding accuracy rates.

Verification of continuous training led to the discovery that an eleven-layer convolutional neural network could obtain the best training outcome in terms of both training time and accuracy. Accordingly, this system will serve as the gold standard against which all other systems will be measured. Considering both the size of the user data and the movie data, this study calculated the optimal size of the first layer of the convolution kernel. Every record has six valid features, so the first layer of the convolution kernel is quite sizable. Score predictions were made using an eleven-layer convolutional neural network, and some example parameter values for this network are shown in Table 2 and Fig. 8.

In this experiment, training on the same dataset is not repeated, regardless of the number of training iterations. Instead, the dataset is split into 300 batches, with 300 data points per input and each training iteration. Overfitting occurs when there is too much training for a given dataset which does not exist. Four hundred unique datasets were used during the testing process for each batch. The results

Fig. 6 2 K-fold cross-validation method

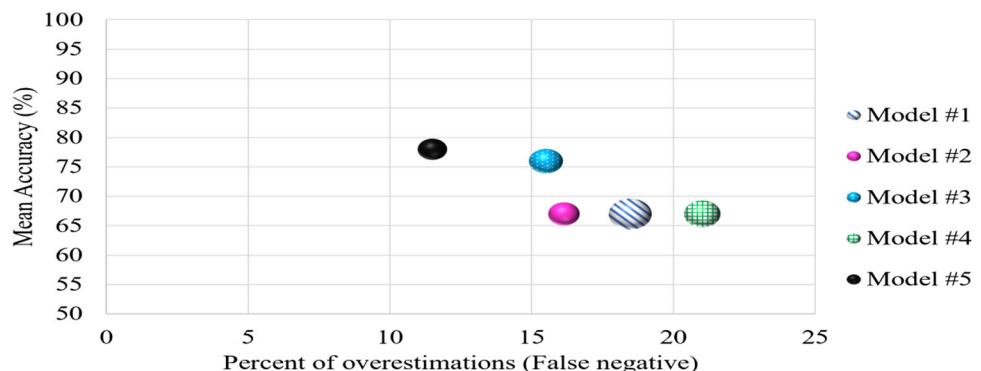


Table 1 The effectiveness of various hyperparameter combinations for convolutional neural networks



No. of replications	Cluster size	CNN layers	Learning rate	Dropout layer	Accuracy%
300	300	5	0.0016	0.60	38.55
300	400	5	0.0012	0.80	19.55
300	400	5	0.0012	0.80	20.56
300	300	5	0.0012	0.80	20
300	300	7	0.0016	0.60	32.54
300	400	7	0.0012	0.80	45.56
300	400	7	0.0012	0.80	43.98
300	400	7	0.0012	0.80	9.55
300	300	11	0.0016	0.60	34.55
300	400	11	0.0012	0.80	54.67
300	300	11	0.0012	0.80	18.56
300	400	11	0.0012	0.80	59.56

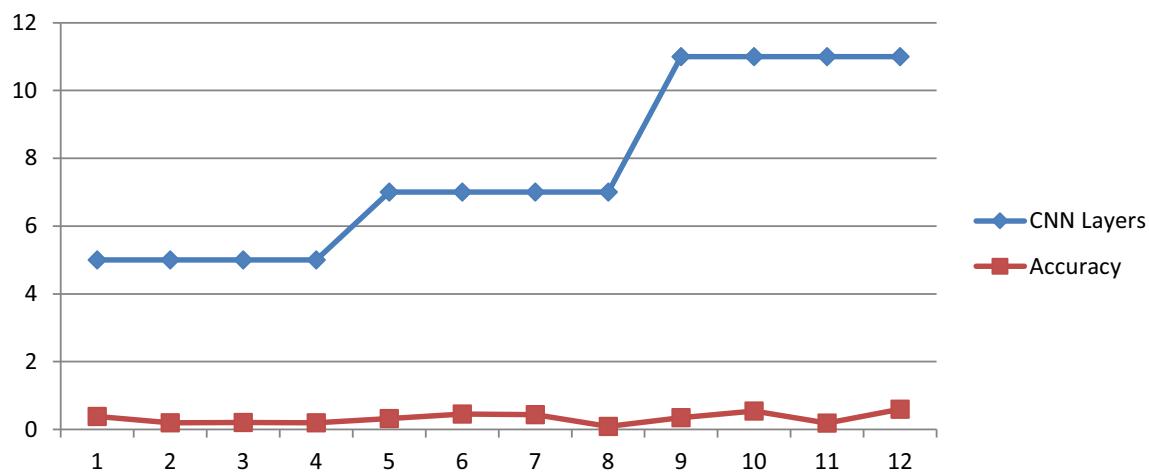


Fig. 7 Accuracy graphs for various hyperparameter combinations in a partial convolutional neural network

Table 2 Convolutional neural network setting diagram with 11 layers

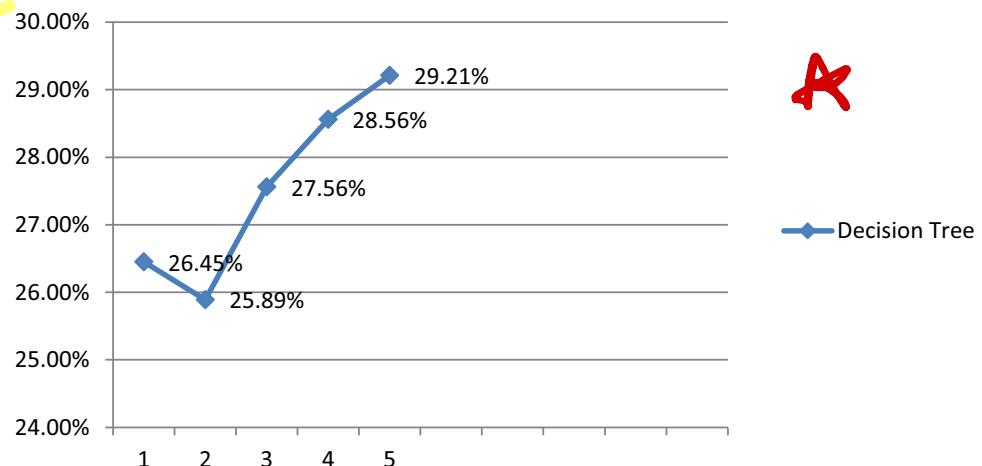
Name of the parameters	Parameter values
Kernel size for convolution	Zhao et al. (2022); Prakash et al. (2018)
Amount of kernels used for convolution	760
Dropout layer ratio	0.73
Cluster size	300
Convolutional layers	11
Steps	1
Number of replications	300
Activation function for a convolutional kernel	ReLU

Showed that as the number of training cycles increased, so did the proportion of proper responses to the training set. Since the model's parameters were established, the test set's accuracy has hardly budged; it has hovered around 59% the whole time.

5.2 The experimental evaluation of competing algorithms

It is essential to evaluate the approach described in this work by contrasting it with other existing algorithms. To the extent that the score prediction is accurate, the performance of the score prediction system improves. Here is

Fig. 8 Relationship between the number of iterations and accuracy



a table of possible parameter settings for several methods for doing comparisons:

- It is called a “support vector machine” when referring to this type of machine. With a gamma of 0.005 and a C value of 200 for the regularization parameter, we employ a Gaussian radial kernel function.
- Making a choices tree criterion is set to entropy, whereas splitter is set to “best.”
- Using naive Bayes, a classification method, each of the two independent dimensions, data, and feature vector, equals 6.

Three alternative machine learning methods were tested, and the results of these tests and the eleven-layer convolutional neural network are shown in Table 3 and Fig. 9. Recent convolutional neural network-based visual expression research techniques for animated films have many advantages over traditional or antiquated approaches and previous machine learning algorithms. If you compare the two methods, you will notice these benefits immediately. Moreover, the eleven-layer convolutional neural net approach proposed in this study outperforms other machine learning techniques regarding accuracy. The outcomes are shown in Fig. 9 and Table 3.

Using AI to generate new script ideas could be an efficient way for filmmakers to complete this task. Machine learning algorithms are fed large amounts of data in movie scripts, which they then analyze, learn from, and utilize to

develop new scripts. As a result, production companies can save much time and money. Artificial intelligence could be used to analyze movie scripts before they are filmed. Screenplay analysis can be simplified and expedited using AI algorithms, which can read the screenplay and suggest questions, doubts, and ideas based on what they discover about the story.

Generative models are a cutting-edge innovation that may generate photo- or film-realistic results in fields like semantic pictures or animation. Disney has used machine learning to streamline the creation and testing of virtual 3D human faces. Disney researchers have created a nonlinear method for modelling 3D faces using neural architectures. This system can learn a network topology and use that knowledge to change a neutral 3D model of a face into a model that expresses the desired emotion.

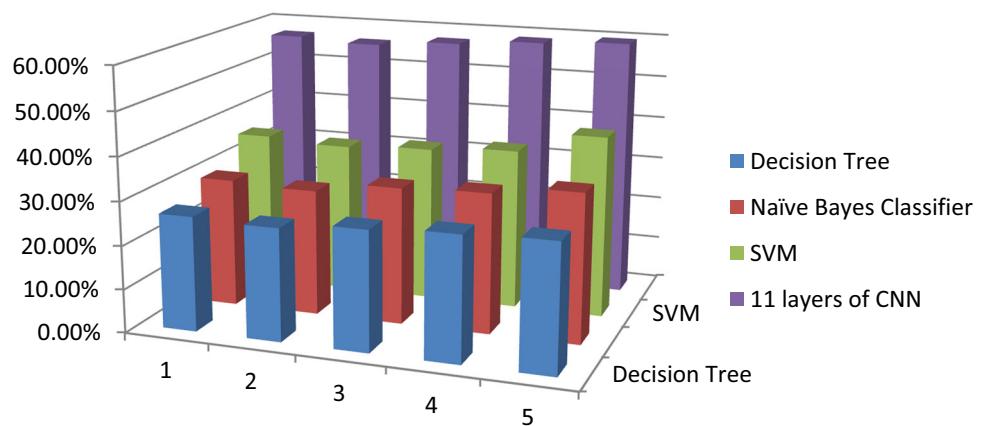
Midas interactive, a firm working on animation technology, on the other hand, has begun to make progress. Ex-Pixar technical director Jiayi Chong has leveraged his skills to create a new Midas Creature program. Using this program, even highly complicated 2D characters may be easily animated. Using the Midas Creature engine, artists and designers can direct the engine to choreograph and figure out the movements independently, thus eliminating the need for character design.

Additionally, AI plays a significant role in the laborious voice-over services conducted in post-production. Adobe has developed new software that uses AI-powered lip-

Table 3 Variations of the accuracy of 11 layers of CNN and the rest of the machine learning algorithms

No. of experiments	Decision tree%	Naïve Bayes classifier%	SVM%	11 layers of CNN%
1	26.45	29.65	35.76	56.89
2	25.89	28.97	34.78	55.97
3	27.56	31.45	35.73	57.34
4	28.56	32.13	36.94	58.63
5	29.21	34.12	41.76	59.56

Fig. 9 Comparisons of the accuracy of 11 layers of CNN and the rest of the machine learning algorithms



syncing to help animators match the lip movements of their characters with the dialogue they say. If you use Adobe Character Animator for animations, use Adobe Sensei, their artificial intelligence engine, to synchronize lip shapes with speech patterns. Figure 10 shows that standard frame-by-frame lip-syncing is applied during the dictation process. As a result, the voice and personality will perfectly synchronize.

Several outstanding algorithms have been developed in response to applications in other fields. They are independent of the network structure, including popular SIFT features, Alex Net, RCNN, GoogLeNet, Faster RCNN, SOLO, and SSD. Besides these, numerous other high-quality algorithms have been created. Many algorithms have been developed to support the present state of the art in artificial intelligence, predicated on utilizing technology

based on convolutional neural networks (CNNs). Introducing a radical shift necessitates a complete overhaul of the underlying processes involved. It consists mainly of taking input images, analyzing them, extracting features from regions within those images, classifying them, extracting partial features, and applying classifiers. You can use a stochastic gradient descent technique to find the best settings for intermittent splicing panels and the associated layers. Because of this, one can get the attributes and categories most relevant to the data's final destination. Figure 11 depicts how a deep recursive convolutional neural network is utilized throughout the platform construction, detection, and verification stages discussed in this study.

As there is an overwhelming amount of data to interpret, the digital image we perceive is a composite of numerous

Algo
eks.

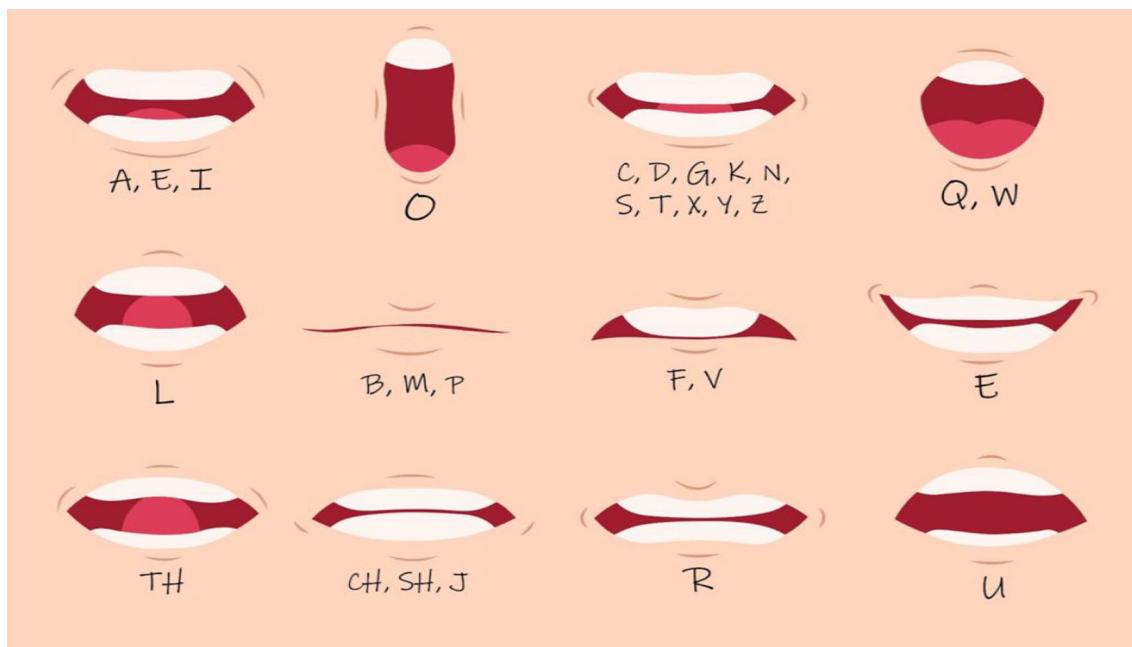


Fig. 10 Illustrating the Adobe character animator

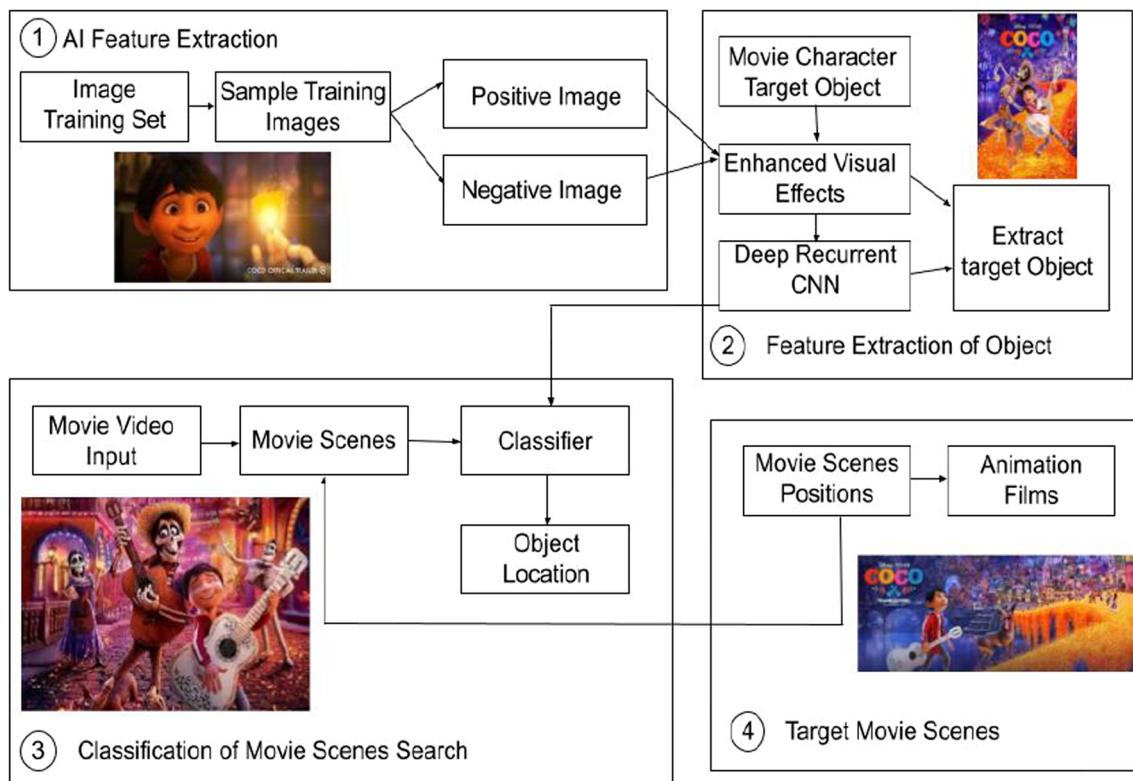


Fig. 11 Recurrent convolutional neural network for advanced visual effects of computer vision in coco animation films

individual images. In the film, high-speed, reliable target recognition and positioning are achieved using a deep recursive convolutional neural network approach. The movie employs this method, which provides techniques to improve object recognition precision. We can do this by tweaking the LOSS function.

6 Conclusion

The research outcome has the potential to both speed up the animation creation process and raise the quality of the final product. However, it may aid in the pursuit of accuracy in animation creation, improving animation quality by increasing the audience's sense of immersion. Responsible use of AI technology requires noting and avoiding the pitfalls seen in other nations. Just as the practical application of animation for cinema and television can broaden the hybrid of animation and other art forms, opening up new possibilities for both, the widespread use of animation for film and television has the same effect.

Following a brief overview of the research on the subject and a scan of the literature, this article digs into the intricacies of the personalized recommendation algorithms that form the backbone of the recommendation system in various sectors. This paper presents a new methodology for

studying anime visual effects and addresses the use of convolutional neural networks in this context. The established algorithm is incorporated into the new visual effects research model of animation film as a method for studying the development of these effects. This procedure follows the typical procedure for testing new possibilities for visual effects in movies. This is the conclusion drawn from an additional study of the new vision animation film principle.

Time and energy constraints necessitate the correction of a few errors in this article. Problems still require fixing, such as the algorithm's cold start, data setup and initialization, data structure, and the right amount of accuracy against recall. Tools and approaches for assessing the effects of AI on the film industry, including but not limited to filmmaking, film criticism, film promotion, and film distribution, are likely to become increasingly popular as the area of artificial intelligence evolves.

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Ethical approval This article does not contain any studies with human participants or animals performed by any of the authors.

Informed consent Not applicable.

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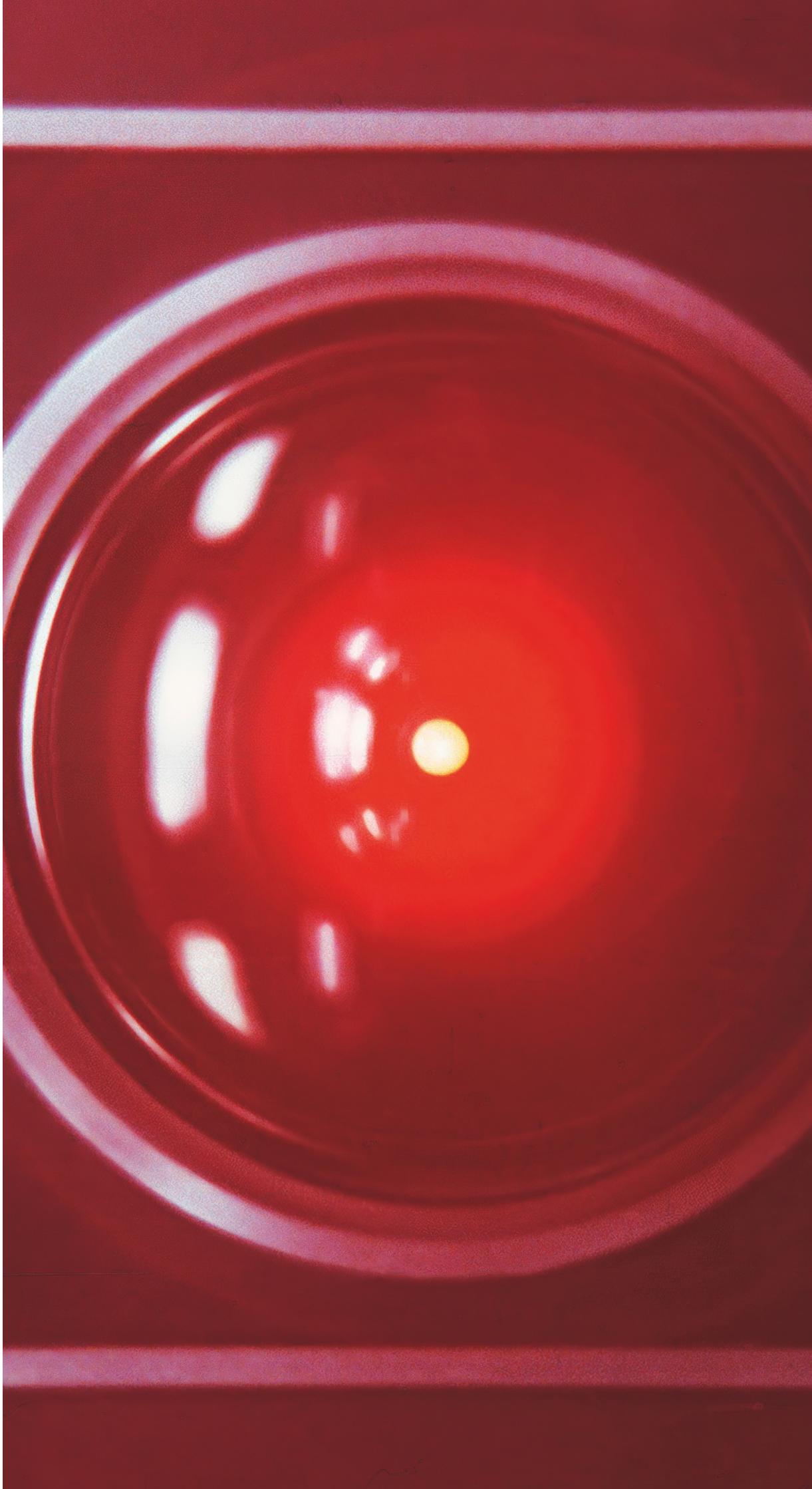
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CINEMA EXWACHNA

Scene 7



THE RAPID DEVELOPMENT OF ARTIFICIAL INTELLIGENCE LOOKS SET TO TRANSFORM EVERY ASPECT OF FILM PRODUCTION, FROM SCREENWRITING AND VISUAL EFFECTS TO THE ABILITY TO CAST DEAD ACTORS IN NEW ROLES, BUT EACH BRINGS WITH IT A HOST OF ETHICAL AND PRACTICAL CHALLENGES

BY DOMINIC LEES

Artificial intelligence has captured our imaginations in film ever since *HAL 9000* appeared in *2001: A Space Odyssey* (1968). Stanley Kubrick continued his exploration of the technology when he optioned a Brian Aldiss short story that was eventually developed into the film *A.I. Artificial Intelligence* (2001), directed by Steven Spielberg after Kubrick's death. For these filmmakers, AI meant an imaginative exploration of a sci-fi concept, a robot boy who could feel love. But today's development of 'generative AI', the term for systems of code that can learn autonomously and create novel texts, images and videos, is impacting on filmmaking itself. This approach to computer coding deliberately mimics the brain, building artificial neural networks that unleash the potential of algorithms to produce 'synthetic media' in a way that is remarkably similar to human creativity.

It is a development both inspiring and contentious: already arguments have ignited about the rights and wrongs of using algorithms to replace human imagination and labour in scriptwriting, performance and the creation of moving images. This article looks at how AI is opening up new possibilities in film production processes and explores the remarkable and highly challenging ideas that confront film culture in the artificial intelligence era.



SCREENWRITING

In 2023, the public accessibility of ChatGPT has raised awareness of AI's potential to generate new storylines and screenplays from simple prompts. Automated production is a pathway to increased profits in any industry, and screenwriters are acutely aware of their vulnerability in the face of AI. When the Writers Guild of America began its strike on 2 May, control of the status of AI-generated scripts was a key demand. The union does not want to ban the use of ChatGPT, but insists that any text created by AI cannot be classed as either "literary material" or "source material". So if a studio exec asks a screenwriter to develop a script from an idea generated by ChatGPT, the resulting work must be classified as the writer's own original screenplay.

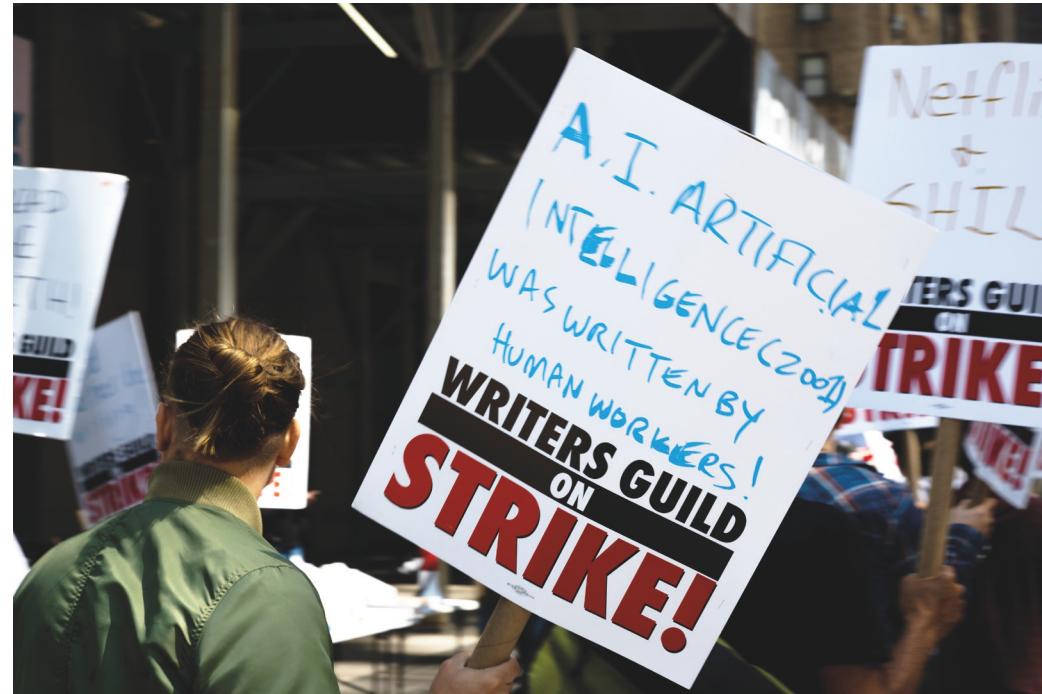
But how good is a script written by ChatGPT? The weakness in this technology is that it is only designed to generate *plausible* text – the chatbot's designers at OpenAI emphasise that it *understands nothing*. This means it is very useful for writing a genre movie based around clear formulae, but has no autonomous capacity for originality. My experience of the system illustrates how its lack of understanding leads to pitiful outputs. I asked it to write a script sequence in which a desperate young woman knocks on my door, on the run after taking part in a botched robbery.

ChatGPT wrote the part of the criminal quite well, but my character was a mess: at first, I was eager to hide her from the approaching police, but half a page later I was moralising to her and saying she should hand herself in. This algorithm has no concept of character consistency.

Specialist algorithms can be 'trained' to learn the style and characteristics of a data set – for instance, the screenplays of a great writer. The implication is that we could input all the work of Billy Wilder, and then write a prompt to the AI to generate a new script, imitating exactly the style of the late great screenwriter-director. The result would be a little like discovering the pages of an unproduced masterwork in his attic – 'Some Like It Hotter'? This experiment would require the consent of the Wilder estate, but the potential for abuse of the AI system is obvious and there is a dearth of clear regulations governing it. Dr Mathilde Pavis, an expert in intellectual property law and ethics, says that judges in the US and the UK will soon be asked to respond to a key question: "At what point does using AI models to imitate the look, feel or style of source materials become infringement of copyright?" She emphasises that the rights of writers are relatively secure, but actors are often unprotected from having their image used to train AI systems, especially after their deaths.

OPPOSITE
HAL 9000, the artificial intelligence that controls the spaceship in Stanley Kubrick's *2001: A Space Odyssey* (1968)

ABOVE
The current Writers Guild of America strike in the US



Possible Deepfake shelter against &

DEEPFAKES AND THE CAMERA

A 'deepfake', a digital video in which the faces have been swapped, is a form of AI that has been part of screen culture for the past six years. Originating with very low-resolution clips created by amateur users, primarily to swap faces in pornographic videos, the technology has advanced rapidly in the last year, progressing from the world of online and mobile-phone content into mainstream television and now the film industry. In March 2021, I reported online for *Sight and Sound* on the extraordinary achievements of a Belgian deepfaker, Chris Ume, whose utterly convincing deepfake videos of Tom Cruise became a TikTok sensation. The following year, Ume deployed his skills on the television show *America's Got Talent*. On to the shiny stage floor was wheeled a studio pedestal camera, setting up in front of a singer for the live broadcast. When he broke into song, the face of the show's judge, Simon Cowell, was deepfaked simultaneously on to the singer's image on the huge screen above. It was a jaw-dropping moment of magic made possible by television's special quality of immediacy. Ume had integrated the studio camera with a computer that could create the deepfakes. The unique advance was to

achieve deepfakes instantly, in real-time: until this moment, the production of high-resolution deepfakes had required long periods of time to train the AI, inputting thousands of source images. Ume's company is aptly named Metaphysic and, together with co-founder Tom Graham, he is now bringing this technology to Hollywood. Their success on *America's Got Talent* led to venture capital investment and an agreement this year with one of Hollywood's largest talent agencies, Creative Artists Agency. CAA is convinced "artificial intelligence will have a transformative impact on content creation and intellectual property".

The first outing for Metaphysic's AI camera technology is with director Robert Zemeckis, who is in production on *Here*, starring Tom Hanks and Robin Wright. The project, developed from a graphic novel by Richard McGuire, is set in a single room across a huge range of time periods. Zemeckis is using Metaphysic's technology to age and de-age his stars in real time while they perform in the studio. The advantage for the director is that he can see the digital transformation immediately. Earlier productions that used VFX to

age or de-age actors, such as Martin Scorsese's *The Irishman* (2019), required weeks of work in post-production before the results could be seen.

This use of AI challenges our understanding of the film camera. Throughout the history of cinema, we have assumed a link between recorded image and reality: what we see on screen is what happened in front of the movie camera during filming. This has been termed the 'indexicality' of the image in both photography and film studies. Cinematographers may have nuanced the image using filters, lenses and matte paintings, but live-action filming conveys to the audience what was there, linking us to the actors who performed before the camera. Metaphysic now gives us a film camera that represents the actors as they are not – it is a technology that transforms reality instead of recording it. No longer are digital visual effects applied in post-production to the recorded images of an actor, as with Brad Pitt in *The Curious Case of Benjamin Button* (2008); the originating image itself is an unreal version of the actor, quite different from how they appeared when performing in front of the lens.

highlighting the
good
deep
team



AI AND VISUAL EFFECTS

An area of film production set to be profoundly affected by AI is visual effects. Previous advances in high-end VFX have made possible the development of studio franchises such as the *Marvel Cinematic Universe*, James Cameron's five-film *Avatar* series and Michael Bay's eight *Transformers* movies. However, a feature of these effects is that they are very slow and expensive, requiring a huge amount of labour by large teams of VFX artists and technicians, meaning that this form of digital image-making has been limited mostly to big-budget productions.

The VFX giant Framestore has recently worked on Marvel Studios' *Guardians of the Galaxy Vol. 3*, written and directed by James Gunn. Its chief technology officer, Michael Stein, spoke to me about the ways in which AI will impact VFX processes. 'Machine learning' can be embedded within existing technologies used to create VFX, accelerating workflows: "The majority of where we think AI will impact the business in the near term is to make everything that we do slightly faster... What we're really trying to do is to get to the better, more quickly."

Speed and automation imply a reduction in costs, which will not only support the bottom line of businesses such as Framestore but could, Stein argues, have a democratising effect on film production: "The tools will open up possibilities to a wider range of creatives. I think a lot of the new AI-based technologies in visual effects are actually targeted at a whole new generation of content creators."

AI means that advanced visual effects will become part of the palette of creative options for all film directors, not just those working in the major studios, meaning we may see shifts in the style of cinema across screen cultures.

But AI technologies threaten employment in this section of the film industry. VFX workforces will shrink: the work of previz artists - 'previsualisation' artists who help plan out how a film will look - in the early stages of VFX conceptualisation will be replaced by accessible systems such as Stable Diffusion, which generates instant synthetic still images; the work of roto artists, who manually trace areas of the live-action frame where the CGI will be inserted, will be automated.

AI MEANS THAT ADVANCED VISUAL EFFECTS WILL BECOME PART OF THE PALETTE OF CREATIVE OPTIONS FOR ALL FILM DIRECTORS, NOT JUST THOSE WORKING IN THE MAJOR STUDIOS

OPPOSITE
Digital visual effects were applied to Brad Pitt in post-production in *The Curious Case of Benjamin Button* (2008)

VFX

ABOVE
Guardians of the Galaxy Vol. 3





FULLY SYNTHETIC FILM

Can, or should, complete movies be made by artificial intelligence? The technology offers this as a reality, with the capacity to generate synthetic actors, images, voices and music. You may well have enjoyed playing with ChatGPT, writing short prompts and receiving back fully formed texts from the algorithm; now, the idea of a parallel system that delivers videos based on your prompts is quite conceivable.

Earlier this year the company Runway released 'Gen-2', an AI that provides this service. A filmmaker can prompt Gen-2 using text and by uploading a still image. The AI then provides the director with an original, synthetically generated shot, which it has created by searching the internet and merging the visual data it finds into a video clip. Many first-adopters are producing highly stylised content, short clips in action or sci-fi genres. Los Angeles-based director Paul Trillo takes a different approach. He told me how he is developing a style of synthetic filmmaking that responds to the nature of artificial intelligence. His starting point is a theory about how an AI engine searches the web before building its videos. Trillo describes how he conceives the AI as conducting a 'hall of mirrors' search across the internet, rather like a person's mind trawling through its memories: "It's trying to reconstruct reality – the AI is amalgamating reality based on memories, the computer is trying to dream." Trillo believes synthetic film should embrace a specific cinematic aesthetic that responds to these qualities of AI.

Last month, he released a short film, *Thank You for Not Answering*, with every

shot generated in Gen-2, and a voiceover through the AI speech-cloning company ElevenLabs. The story is about an elderly man making a phone call to a lover from long ago, leaving a voicemail that revisits the relationship through memories. Trillo describes the rushes the Gen-2 algorithm delivered: "There's a murkiness at first glance. It looks like reality, but when you look a little harder the details of life are kind of missing. And I thought that was kind of what memories are like, where you try to remember something and can only feel the person, the place, the mood." The moving images created by Gen-2 have strong similarities to animation, but have a special characteristic: "I think AI video has this inherent haunting, almost grotesque quality."

Trillo's comment reflects my own experience experimenting with deepfakes in film drama. When I attempted to replace the face of an actress with that of Margaret Thatcher, the first image that the algorithm delivered was a distorted face of the prime minister, with two mouths, like a Francis Bacon portrait.

The image was horrifying yet had a quality that was strangely resonant, for some of us, of the political realities of the 1980s. Yet the subtexts, tone and emotions we read in AI-generated images don't originate from filmmaker intention; the style is generated by a machine. The AI does not know an image is horrific: it understands nothing, merely obeying prompts and delivering images that the algorithm decides will best reflect the commands. Its work is a form of automated randomness.

Trillo believes that directors using AI should not just embrace its particular

aesthetic, but also welcome the "oddities" it generates. He singles out one shot in his film – a woman in a dimly lit room or hallway, her face almost featureless under a wash of green light – that he regards as a wholly original creation by the AI. "It wasn't something I asked for, it wasn't even close to what I had asked for, but it was a really haunting and striking image."

The AI had behaved like a wayward director of photography, delivering rushes the director did not want. But when Trillo saw the shot, he found it fitted beautifully into the language of the film, and he incorporated it into his edit.

This leads to an interesting question about the role and status of the director in AI film. The creative practice involved can be entirely solitary, with the filmmaker working alone at a computer, uploading reference images and crafting prompts to the AI to generate the rushes for the movie. This implies a form of pure auteurism, replacing our normal understanding of collaborative authorship in filmmaking. But how much credit should we give to the AI?

"It's hard for me to take full credit for some of the decisions it's making because there's things that I didn't direct," Trillo observes. "I find it closer to curation in some ways than directing, because of that randomness." For this reason, in the film's credits he puts the director attribution in inverted commas: "Written and 'Directed' by Paul Trillo." The question links back to the issues involved in the screenwriters' dispute, but whereas the Writers Guild of America demands that AI-generated text should not be allowed creative status, Trillo suggests we should give AI more credit for its originating role.

It always seems easier to run away from it

THE FUTURE OF AI AND FILM

Joe Russo, co-director of *Avengers: Endgame* (2019) and an enthusiast for new technology, recently speculated that AI will ultimately lead to the creation of on-demand personalised movies. He suggests that in the future he will return home and say to his voice recognition system, "Hey, I want a movie starring my photoreal avatar and Marilyn Monroe's photoreal avatar. I want it to be a romcom because I've had a rough day," and the AI will deliver a 90-minute feature. It is certain that the technology will take us down extraordinary paths and we will argue over the desirability of the alternative forms of cinema culture that it will present. AI enthusiasts disagree among themselves: Framestore's Michael Stein argues against the personalisation of film described by Russo: "As humans, we like to share in stories, right? If everyone is living their own unique stories, how do we share them?" This brings the discussion to the vital issue of how film audiences will respond to new uses of AI. Will they engage with synthetic actors? Will they embrace a new cinematic style that is particular to AI-generated moving images? There is huge risk for filmmakers both in finding ways to use the new technology and in negotiating new relationships with their audience.

great rhetorical questions I can discuss with



THE ISSUE IS HOW FILM AUDIENCES WILL RESPOND TO NEW USES OF AI. WILL THEY ENGAGE WITH SYNTHETIC ACTORS? WILL THEY EMBRACE A NEW CINEMATIC STYLE PARTICULAR TO AI-GENERATED MOVING IMAGES?

Timeline is great! 103

AI SYSTEMS IN FILMS

- 1957 • THE INVISIBLE BOY Arrival of the malicious supercomputer.
- 1965 • ALPHAVILLE Howard Vernon's sentient computer Alpha 60.
- 1968 • 2001: A SPACE ODYSSEY HAL 9000.
- 1973 • WESTWORLD Faulty AI leads to androids running amok.
- 1979 • ALIEN AI mastercomputer MU-TH-UR (or 'Mother').
- 1982 • TRON A power-hungry Master Control Programme.
- 1983 • WARGAMES An AI researcher automates the nuclear arsenal.
- 1984 • THE TERMINATOR Resistance against Skynet, the AI reaching self-awareness.
- 1999 • THE MATRIX Intelligent machines have created a simulated reality.
- 2001 • A.I. ARTIFICIAL INTELLIGENCE An AI boy feels love.
- 2004 • I, ROBOT An AI wants to save humanity from self-destruction.
- 2009 • MOON An AI controls clone workers on the moon.
- 2011 • RA.ONE Anubhav Sinha's games computer goes rogue.
- 2013 • HER A lonely male writer falls in love with AI 'Samantha'.
- 2015 • EX MACHINA Ava, the humanoid who has passed the Turing Test.
- 2019 • CAPTAIN MARVEL The 'Supreme Intelligence' rules an alien race, the Kree.
- 2022 • BIGBUG Jean-Pierre Jeunet's comedy about domestic AI.

LEFT
Steven Spielberg's
A.I. Artificial Intelligence (2001)

OPPOSITE
Paul Trillo's new short
Thank You for Not Answering

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