Humanities, Arts and Social Sciences Studies

Review Article

Humanities, Arts and Social Sciences Studies
https://so02.tci-thaijo.org/index.php/hasss
ISSN (Online): 2630-0079

VISUAL AESTHETICS OF NARRATIVE ANIMATION OF 3D COMPUTER GRAPHICS: FROM BOTH REALIST AND EXPRESSIVE POINTS OF VIEW

Mars Caroline Wibowo[1], Sarwo Nugroho[1], and Agus Wibowo[2]*

[1] Faculty of Graphic Design, University of Science and Computer Technology (STEKOM University), Indonesia
[2] Faculty of Computer and Business, University of Science and Computer Technology (STEKOM University), Indonesia

Corresponding author:
Agus Wibowo
agus.wibowo@stekom.ac.id

Received: *22 February 2023*
Revised: *24 July 2023*
Accepted: *25 July 2023*
Published: *30 April 2024*

Citation:
Wibowo, M. C., Nugroho, S., & Wibowo, A. (2024). Visual aesthetics of narrative animation of 3D computer graphics: From both realist and expressive points of view. Humanities, Arts and Social Sciences Studies, 24(1), 241–255.

ABSTRACT

The field of animation is a unique realm for artistic creativity to convey stories. Animation is a technique in which images are manipulated to display moving visuals. In traditional animation, images are painstakingly hand-drawn or painted on transparent celluloid sheets, which are then photographed and showcased on film. The process of creating 3D animation is highly intricate and time-consuming. Animators must consider numerous factors to produce high-quality, visually stunning animation. The current study aligns with the ongoing development in computer graphics, which are influenced by the hyper-realist ethos. The study delves into animation aesthetics, computer graphics technology, and culture within the realm of 3D animation. For comparison, it also presents the findings of researchers and computer graphics experts, focusing on more expressive 3D narrative animations. This study merges research in art history, computer graphics, psychology, and expressive visual style, particularly their naturalistic attributes and emotional engagement. Regarding the potential for natural expression, this study draws upon two fundamental aspects of 3D technology: photorealistic rendering and one-point perspective. It is expected that future technological advancements will further enhance the evolution of expressive aesthetics in 3D animation. In conclusion. this study emphasizes that future 3D animation creation should prioritize aesthetic expressiveness.

Keywords: 3D animation; realism; aesthetic expressiveness; naturalism; photorealistic

1. INTRODUCTION

For over a century, animation has evolved into a highly captivating and intriguing art form. Presently, artists from various artistic disciplines incorporate animation technology into their creations. The history of 3D animation is often traced back to early works like *Humpty Dumpty Circus* (see Figure 1), where characters made from paper were manipulated to achieve movement. This pioneering work dates back to 1898 (Crafton, 1993). The first full-length feature film to prominently feature 3D animation elements is *The Lost World*,

released in 1925 and directed by Willis O'Brien, who later gained acclaim for the 1933 film *King Kong* (Doyle, 1998; Morton, 2005). Both of these films utilized clay modeling and puppetry techniques to bring stop-motion animated creatures to life (Morton, 2005). Ray Harryhausen drew inspiration from these early works and went on to create his own influential pieces such as *Mighty Joe Young* in 1949 and *Clash of the Titans* in 1981 (Hankin, 2008). In the context of animation, the act of animating an object essentially means imbuing it with lifelike movement. This definition has expanded in the realm of computer animation, where even stationary objects can be considered part of animation. Static animation, characterized by the absence of motion, is employed when a detailed introduction of an object is required for the audience's comprehension. Given the capabilities of television media and its technology to convey moving images depicting human, animal, and plant activities, animation has become a popular form of entertainment that can be showcased on TV (Fielding, 1967).

Figure 1: *Humpty Dumpty Circus*
Source: Bark (n.d.)

Animation is preferred by viewers because of the accompanying motion element, compared to still images or photos. The presence of moving images can evoke the audience's enthusiasm and emotions (Jou et al., 2014). Audience preferences on the various forms of animation can differ greatly due to personal taste, cultural backgrounds, and age groups (Ishii, 2013). Some viewers may gravitate towards traditional 2D hand-drawn animation for its nostalgic charm and artistic craftsmanship. Others may prefer the sleek and realistic visuals offered by 3D computer-generated imagery (CGI), which often provides a sense of immersion. Stop-motion animation enthusiasts appreciate the tactile and tangible quality it brings, with its distinct character and charm. Additionally, certain audiences may be drawn to specific animation genres such as anime, which has a dedicated fanbase worldwide. Furthermore, the rise of innovative techniques like motion graphics and mixed media animation has gained popularity among viewers seeking cutting-edge visuals and unique storytelling approaches.

The utilization of 3D animation technology has become increasingly prevalent in various activities, thanks to ongoing technological advancements that facilitate the enjoyment of animation at any time and place. The evolution of 3D animation can be recognized as a cultural development, encompassing both its products and cultural attitudes. Devices capable of displaying digital images, such as gadgets, also double as platforms for animation. Currently, numerous promotional campaigns employ animation as a means of conveying messages. In the 2000s, creators made concerted efforts to push the boundaries of 3D animation. However, regrettably, not much progress was achieved in terms of storytelling and overall aesthetics in 3D animated films. In contrast, 2D animation offers smoother movement and aesthetics. Consequently, a method emerged, with most studios beginning to merge 3D and 2D animation. In this approach, characters are meticulously designed to replicate real-life movements, enhancing the viewer's experience. To ensure effective communication through animation, aesthetics must be integrated into the characters to enable clear message conveyance to the audience. The incorporation of aesthetic elements adds beauty to the medium, making it more appealing to a broader audience and facilitating information dissemination. As such, understanding the role of aesthetic values in the communication process through animation media is essential.

2. NARRATIVE ANIMATION AND 3D COMPUTER GRAPHICS

According to Limano (2019), animation is a tangible medium that presents a sequence of images that are rapidly and repeatedly displayed to create the illusion of eyesight. In the realm of 3D computer graphics technology, 3D modeling involves the process of constructing mathematical representations of 3D objects, which can be living or non-living, through the use of specialized software. The resulting creations are referred to as 3D or three-dimensional models (Ahearn, 2014). Through an existing process called 3D rendering, these images can be displayed as two-dimensional images. This process can also use computer simulations of physical phenomena. To create realistic models of the environment, most systems use a combination of range and image sensing. These systems address the problem of aligning 3D range data with 2D images by rigidly attaching the camera and range sensor to the same platform, thus fixing their relative position and orientation (Liu & Stamos, 2005).

Nevertheless, these explicit 3D representations inherently discretize continuous surfaces, and modifying the morphologies frequently necessitates additional repair procedures such as remeshing (Alliez et al., 2002). These discretized and manipulated 3D structures are unable to preserve geometry and appearance details, resulting in unappealing novel views. In light of this, Wang et al. (2022) designed a new pipeline that can recover continuous 3D scene geometry from only 2D views and enable object decomposition and manipulation. In addition, they asserted that lighting factors are not decomposed and that edited objects exhibit inconsistent illumination. Eventually, the development of 3D animation technology has been strongly influenced by the ethos of art ideas that are realism and naturalism.

The term 'realism' in the context of animation has evolved into a complex and ongoing subject of debate. Research investigating the connection between computer performance capture and the creation of a genuinely realistic animation experience remains quite limited within the animation industry. These issues extend far beyond aesthetics and artistic conventions as they encompass a wide array of questions related to phenomenology, epistemology, and ontology, transcending the boundaries of mere aesthetics (Wagner & Jang, 2016). This perspective aligns with the views of historical figures, including Plato and Aristotle, who introduced the concept of 'mimesis' and significantly contributed to the discourse on art. In addition to pragmatic, objective, and expressive approaches to art analysis, Abrams (1953) included mimesis as a fundamental lens. Mimesis, in a sociological context, can be considered a primary and vital guide for understanding art. The theory of mimesis has given rise to numerous methods of art criticism. In memetic philosophy, the term 'realism' often serves as an honorary designation for art created in a familiar style or characterized by loyalty to nature. However, its ontological significance within the realm of epistemology is neither ambiguous nor challenging to discern.

Realism within the arts pertains to the choice of subject matter and the manner in which it is portrayed. In the context of realistic art, the focus often leans toward representing lower social classes, the everyday aspects of life, such as comics rather than tragic narratives, and the ordinary as opposed to mythical. In the realm of realism, the nature of the image varies between different art forms. In traditional painting (non-photographic) and animation, the artifice of the image is quite apparent. Conversely, lens-based art, as seen in photography and cinema, produces images with distinct properties. The evolution of non-lens-based visual arts has, over time, profoundly explored the denaturalization of themes and techniques. Photorealism plays a dominant role in evoking emotional engagement with the audience. It transforms how characters are perceived, enhancing the sense of presence within a physical space and contributing to enhanced visual appeal (Zibrek et al., 2019).

Photorealism in computer graphics is the creation of images that closely mirror reality, simulating scenes as if they were captured through photography (Joon, 2010). Within the realm of visual realism, the standard for assessing it is commonly associated with naturalism, often perceived as a precursor to photorealism (Rysiew, 2016). It is important to note that while realism and naturalism can coexist, they are not one and the same. Realism typically focuses on portraying the harsh realities of human life, whereas naturalism aims to depict subjects in harmony with or in accordance with nature. Realism in art means the effort to present the subject in a work as it appears in everyday life without the addition of certain frills or interpretations. In the context of art and animation, the terms realism and naturalism are frequently used interchangeably, representing a visual style or audio-visual mimetic representation that aspires to achieve photorealism or cinematism. Sheng (2018) has noted that the term 'realism' within the visual arts can be perplexing, as it relates to what E. H. Gombrich argued, where naturalism embodies and reflects a more generalized idea concerning the faithful representation of reality (verisimilitude) in artistic works, distinct from the potentially ambiguous nature of language itself. Naturalism has indeed become a global and interdisciplinary movement and genre, spreading across Europe and beyond (Dodworth, 2019). Both terms, realism and naturalism, are suitable for research purposes, although naturalism is often favored for its ease of

comprehension, particularly when representing 3D animation technology that demonstrates a strong internal logic.

In the theory of artistic expression, the primary element of a work of art that holds the utmost significance is not its physical form, but rather the thoughts, concepts, and ideas that flow from the artist. This process enables art enthusiasts to connect with the artist's emotions and experiences (Tormey, 2015). The quality of a work of art is often deemed excellent when the message and expression intended by the artist can be effectively conveyed to the audience. Debates surrounding the theory of art as a form of expression have a long history. According to Robinson (2017), expression is fundamentally an act carried out by an imagined agent (such as the artist, narrator, or implied character), or it can be seen as something they are imagined to do.

Character-based animated expressions play a crucial role in effectively conveying emotional messages to the audience. The impact of art and painting on user's emotions underscores the significance of visual style in shaping emotional perceptions and responses. Numerous past psychological studies have demonstrated a correlation between the rendering style and an individual's perception and emotional response to specific objects. Additionally, various studies have explored the connection between color and emotion (Wilms & Oberfeld, 2018). In 3D narrative animation, the favored expressive style is often linked to speech or dialectical approaches. Creators in the realm of 3D animation frequently strive to cinematically mimic external realities while infusing their work with expressive elements rooted in perception, emotion, and imagination. Film theorists Vivian Sobchak and Laura Marks assert that the film experience encompasses a multisensory aspect, involving touch and taste, beyond just visuals and cognitive elements (Noheden, 2013).

Based on the expressive style it embodies, the art of animation is often regarded as one of the most compelling forms of visual art when compared to other art forms. However, in the realm of 3D animation, there can be a preoccupation with the quantitative aspect over qualitative elements, as indicated by Fan et al. (2018). This emphasis on quantity may be attributed to the prevalence of calculative and computer-based quantitative analysis. Moreover, the central question to address revolves around how technology and culture, which prioritize aesthetics, can be seamlessly integrated into creative and expressive works. The creation of a work aims to provide value, and in this context, expressiveness often holds more advantages than realism. If the primary objective of computer graphics technology is to achieve realism, these aspects are intrinsically tied to completeness (Beneš et al., 2017). In simpler terms, the concepts of imperfection, incompleteness, and subjectivity significantly influence interactive participation, enabling the fulfillment of expressive values.

3. PHOTOREALISM AND 3D COMPUTER GRAPHICS

An illusion of motion is achieved by presenting slightly different images in rapid succession. Animation is the process of organizing and capturing still objects to produce the necessary images for creating this illusion of movement (Güdükbay & Durupınar, 2008). In the realm of 3D computer graphics, the development of animated works that adhere to a naturalist aesthetic is influenced by a confluence of historical, technical, cultural, and commercial factors. The primary concept within computer graphics-based research is the synthesis of images to enhance their realism (Thies et al., 2019). The pursuit of more realistic images has spurred advancements in modeling, appearance algorithms, and rendering techniques in animation technology. The discussion surrounding photorealism is inseparable from its core objective, which is to create images that are indistinguishable from photographs of real scenes. Yet, a comprehensive and precise definition of photorealism often leaves psychologists grappling for clarity in addressing this question. Their explanation is often limited to the notion that photorealism pertains to the faithful reproduction of photometrically realistic images.

An image is expected to evoke the same visual response as the subject it represents, even though the energy emanating from the image object seen by the eye may differ from the original. The interplay between applied science, research, and technological advancements significantly influences the objective evaluation of a work compared to subjectivity. Technological reproduction, as seen in photography, painting, and recorded music, enables art consumption in vastly different times and places from the original, potentially altering the original meaning based on the context of its creation (Couto & Indrayuda, 2012). In the realm of art and production design, both in graphics and animation, digital technology is progressively replacing analog technology as it continues to advance (Berisha-Shaqiri & Berisha-Namani, 2015). Concurrently, 3D animation has seen substantial development, driven by the ever-advancing capabilities of 3D computer graphics technology.

Computer-aided design/computer-aided manufacturing (CAD/CAM) represents an evolution in computer graphics technology, initially developed in the manufacturing industry (Wang & Bi, 2019). CAD was conceived to drive technological advancements and streamline the work of drafters, animators and designers.

The use of CAD/CAM for analysis allows for the real-time adjustment of parts in the resulting product during use, akin to movement animation. The core function of CAD applications is to simplify the modeling of physical objects and structures within a 3D space (Leen et al., 2017). The pivotal role of CAD/CAM systems has catalyzed a remarkable surge in both products and procedures in recent decades, accompanied by a proliferation of publications and research on the topic (Abdullah et al., 2018). CAD/CAM are widely adopted in diverse fields, including car design, architectural design, military equipment, medical imagery in the healthcare sector, and its integration into animated films, all of which fall under the purview of 3D computer graphics technology. One prominent example of this technology is *Autodesk Inc.*, the creator of *Autodesk Inventor* and *AutoCAD*, each specializing in 3D object design. *AutoCAD* technology is tailored for creating architectural, civil, mechanical, and electrical designs, while *Autodesk Inventor* is primarily geared towards mechanical designs (Biehler & Fane, 2014). The development of CAD systems continues to evolve, adapting solutions to cater to the demands of 3D animation creation. This is evident through the availability of 3D applications like *Studio Max (3DS Max)* and *Maya*.

Li (2021) examined the practical significance of artificial intelligence (AI) AlphaGd, highlighting its powerful capabilities in enhancing the visual appeal of animations and driving innovation in animation production technology. The author concluded that the utilization of AI AlphaGd in the creation of film and television animation results in more lifelike and detailed character depictions, as well as enhanced visual effects. These improvements contribute to a more enjoyable and immersive viewing experience for the audience. Moreover, Gong (2021) observed that the rise and advancement of AI technology have led to its gradual incorporation into the realm of digital media art creation using virtual reality technology. This integration has resulted in enhanced convenience and improved services for digital media artists, thereby stimulating the overall progress of the field of digital media art creation.

The adoption of visual effects technology in films is on the rise. Research by Michelle et al. (2017) highlights that viewers increasingly desire realistic imagery in movies and are eager to embrace new technologies that deliver these lifelike visuals. Beyond the film industry, there is a substantial and growing demand for 3D mobile apps and games (Chen et al., 2015). The gaming sector, in particular, has witnessed a surge in demand for 3D technology, primarily due to the impact it has on the player's experience. The advancement of 3D stereoscopic gaming, facilitated by 3D animation technology, plays a pivotal role in driving this industry forward. Figure 2 shows the global 3D animation market value from 2018 to 2029.

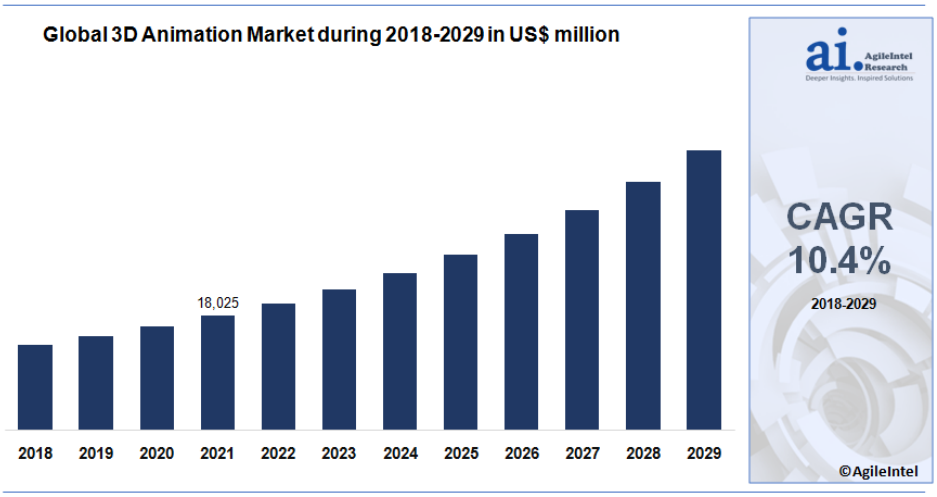

Figure 2: Global 3D animation market value
Source: *Global 3D animation market size, trends and forecast to 2029* (2022).

Currently, the application of CAD has permeated various industries seeking more compelling media to enhance their product marketing efforts (Kosmadoudi et al., 2013). Within the architecture and construction sector, the demand for fast and visually captivating design animations has led to a substantial increase in the adoption of 3D animation technology (Dib & Adamo-Villani, 2014). One of the most notable areas where 3D animation finds extensive application is in the education sector. Here, the development of e-learning platforms, training applications, and 3D animation products for learning, particularly in the creation of educational video content, has proven highly appealing to students (Roopa et al., 2021). Numerous educational institutions, ranging from elementary schools to universities, now offer sophisticated e-learning platforms. These variations in market demand are influenced by historical, cultural, and technological factors. In the field of health and

medicine, the use of computer-aided diagnosis technology is imperative for body image simulation, anatomical studies, surgical planning, and patient communication (Ovunc et al., 2021). Computer-aided diagnosis employs machine learning techniques to examine both imaging and non-imaging data derived from previous cases within a patient population (Chan et al., 2020). This analysis enables the development of a model that links the extracted information to specific disease outcomes. The use of computer-aided diagnosis as a secondary reader has been proven to enhance the identification of early-stage breast cancer (Taylor & Potts, 2008). However, the resulting higher rates of recalling patients for further evaluation and increased reading time have drawn criticism.

Currently, software for computer graphics applications within the arts and entertainment industry predominantly focus on three primary market segments: 3D games, various types of animated films (comprising short films, advertisements, and feature-length productions), and the creation of special effects (SFX) (Rahani et al., 2018; Tang & Ho, 2020). Each of these areas has its unique set of aesthetics. In the case of the SFX industry, the emphasis is on achieving realism. A notable example of this is *Disney's* animated film *Encanto*, which earned the 2022 *Oscar* in the Best Animated Feature. This film is deeply rooted in Colombian culture. *Disney's* classic, *The Lion King*, is still regarded as one of the finest animated films ever created. Behind the making, animators extensively studied wildlife documentaries to achieve realistic animal depictions. The unique and iconic animation style of *The Lion King* resulted from months of careful observation by the animators, who relied on numerous wildlife documentaries to capture realistic lion movements. The pursuit of aesthetic excellence is an endeavor aimed at establishing a means of emotional communication that provides satisfaction and comfort through beauty. While aesthetic awareness remains relatively constant, what changes is people's interpretation of works that contain expressive values. The examination of expressive aspects gains deeper significance when used to elucidate emotional reactions. The expression in a work of art adheres to stringent rules and can be analyzed rationally, delving into various elements, including points, lines, planes, proportion, scale, harmony, unity, function, and more. In the creation of art, emotion plays a paramount role in realizing an idea in the desired visual form (Uhrig, 2018). Instinct, in addition to emotion, also significantly contributes to the creative process. However, this does not imply that intellectual elements are entirely absent from artistic activities. On the contrary, in various scientific disciplines, understanding aesthetics remains closely connected to intellectual factors.

4. EMOTION AND AESTHETIC EXPRESSION

Emotional expression in art signifies emotions not through mere resemblance, physical connection, habit, or convention, but rather through the use of special types of symbols. These symbols signify emotions by invoking an interpreter—a state of perception that the observer may or may not directly experience— and this state associates the expression with the conveyed emotion (Glazer, 2017). Artistic works are created with the intent of delivering an aesthetic experience, setting them apart from other human-made physical objects. This distinction arises from their structured organization and pleasing form. The impact of art and painting on the user underscores the importance of visual style in shaping the user's emotional perception and response. Several past psychological studies have indicated a correlation between the rendering technique's style and the viewer's emotional response to a particular object (Duke et al., 2003). In the realm of natural aesthetics, it's essential to distinguish the concept of an image from the psychological constructs developed by English and German empiricists (Mikki, 2021). Animated art serves as an expression of the animators' creativity, employing their unique visual language and the "aura of chaos," immaculate simplicity, or likeness (Sheng, 2018). The expressiveness of artwork appears to directly convey emotions to the audience, profoundly evoking emotional responses from viewers.

In his book *The Principles of Art*, Collingwood (1938) asserted that art is a product of imaginative expression rooted in emotion. The notion of emotion appears to be fundamental in discerning something as possessing an expressive quality. Perceiving the expressions in objects appears to necessitate a form of emotional thought, specifically emotional thinking connected to visual perception. It seems imperative to possess a concept of emotion to recognize a display as expressive. Lopes (2005) contended that the expression of emotional connections is essential for distinguishing configurations from mere physical arrangements. The relationship might be deemed non-perceptual, but its significance in the context of display-expression remains somewhat unclear. Japan boasts a steadfast and well-preserved cultural tradition with distinct aesthetic values. In contrast, American filmmaking has adapted in response to changes in production methods, evolving audiences, and various industrial and commercial requirements. The Japanese aesthetic often veers toward the supernatural and finds expression in the narrative and visual style of works like 'Ringu.' However, the distinct aesthetic of 'Ringu' is not solely emblematic of Japanese culture and draws inspiration from Hollywood's approach to horror, as evident in the film's opening scenes and narrative development.

It appears that many works of art aspire to elicit an aesthetic response. The theory of communicative emotion posits that cognitive evaluations of situations have the potential to trigger emotions (Johnson-Laird & Oatley, 2021). In psychology, emotions extend beyond mere feelings; they encompass a complex amalgamation of actions, expressions, and internal changes. Emotions emerge as responses to the meanings constructed from one's environment. According to *Psychology Today*, individuals experience emotions when specific aspects of their current situation capture their attention. Emotions represent the somatic manifestations of an event's importance within the natural or social world for the individual (Bericat, 2012). Emotions revolve around an event, circumstance, or object deemed to hold potential significance for an individual's well-being (Shields & Zawadzki, 2012). Art, by engaging with aesthetics, has a profound impact on us, instinctively triggering and stimulating emotions, which are subsequently subjected to cognitive control and reflection.

5. CREATIVE EXPRESSIVENESS OF 3D ANIMATED WORKS

A work of art gains value and meaning when the artist optimally expresses it, taking into account various factors that support its realization. Artwork often have the power to evoke profound experiences in their audiences (Brinck, 2018). For instance, cultivating the right mood becomes a key element in realizing an optimal and valuable work of art. According to Robinson (2005), successful artistic expression is achieved when it elicits the intended emotions in the audience. A work of art gains value and meaning when the artist optimally expresses it, taking various critical aspects into account.

The animated film genre is primarily crafted using CGI in computer graphics, offering a consistent blend of form, style, and content. Most animated films target children and families, exemplified by Disney's emotional character-rich production, *Mulan*, released in 1998 (Bancroft & Cook, 1998). The history of animation has been significantly shaped by the evolution of digital technology. In the 1990s, pivotal changes emerged with milestones such as Pixar Studio's introduction of *Toy Story* in 1993, the inaugural 3D animated film lasting 1 hour and 21 minutes. This era also witnessed the creation of DreamWorks' *Shrek* (Adamson & Jenson, 2001), which clinched the first Academy Award for Best Animated Feature and a nomination for Best Adapted Screenplay. Another CGI animated gem, *Ice Age* (2002), produced by *Blue Sky* Studios (20th Century Fox), was recognized with an Academy Award nomination in the Best Animated Feature category.

The Lion King (2019) is a CGI adaptation of the *Walt Disney* animated film from the 1990s. In the remake, director Jon Favreau aimed to fully harness the potential of virtual production technologies. During discussions with journalists invited to the film set, Favreau revealed his plan to create a virtual space within the Unity game engine and employ live-action techniques for shooting, effectively turning the production process into a virtual one (Ha, 2019). Notably, the development of virtual production was significantly influenced by the film *Avatar* (2009) (Glotov, 2022). *Avatar* skillfully blended computer-animated motion capture images with a virtual camera system, allowing director James Cameron to visualize the CGI characters while observing the actors in their motion capture suits. These films are the main focus of this study and other works that fulfill the 3D aesthetic elements in the development of a better expressive style.

The animation industry still adheres to traditional animation methods, where the workload is primarily handled by artists responsible for tasks ranging from creating character models and outlines to establishing keyframe poses (Chen & Li, 2016). Julie Taymor, an American theater, opera, and film writer and the visionary behind the film adaptation of *The Lion King* (1994), emphasized the artist's capacity to reshape reality, making the cinematic experience more captivating. Taymor highlighted the expansive impact of an expressive style on interactive relationships with art enthusiasts, evoking their aesthetic and imaginative connections. Aesthetics have perennially been a focal point of both filmmakers and audiences, exerting a significant influence on the art and entertainment industry.

The theory of art as expression places focus on within the realm of art and dedicates a significant portion of its theoretical framework to describing and understanding the intricate relationships, transformations, and consequences of emotions in art (Jacquette, 2014). Researchers acknowledge that emotional experiences are inherently subjective, with unique emotional experiences exhibiting a rich multidimensionality. Emotions, when intertwined with connotations that carry both metaphoric and synesthetic resonance, can assume the role of a multimodal neural hyper-stimulus, effectively encapsulating the essence of an entity within an aesthetic context. Understanding an artist's technique and visual aesthetics, particularly when delving into the physical processes of the eyes and brain, poses an enduring challenge (Lam, 2014). An even greater challenge arises when attempting to replicate a specific painter's technique. This endeavor necessitates the development of sophisticated models of visual representation within the visual cortex, complemented by higher-order cognitive processes.

To somatically tag an image is to evoke visceral and automatic affective reactions closely tied to, rather than merely caused by, the image itself. The response to naturalistic images and videos, along with their

imitations, involves a blend of expressive styles in animation. Rotoscoping technology offers intriguing possibilities in animation. The decision to employ rotoscoping is driven by the pursuit of realistic human movement rather than cost considerations. Although rotoscoping has been adopted by numerous studios over the years, few openly acknowledge its use, as many in the animation industry view it as fraudulent and a violation of the art of animation. Notably, Walt Disney Studios utilized the rotoscope technique in 1937 to craft character movement in *Snow White*. An animator may choose to convey an expressive aesthetic in their work through a variety of modalities, including music, dialogue, light effects, characters, settings, movements, narrative dynamics, and complex isomorphic or metaphorical interactions between these modalities. This choice is driven by multiple artistic considerations

The impact of expressiveness can be significantly altered by creating harmonies or pivotal moments across various modalities, which may encompass the use of metaphors. Metaphors are imaginative combinations of similarities and differences that provide insight into the creative capacity to merge different, and at times even contrasting, phenomena. Metaphor stands as one of the neuroaesthetic principles, according to Laverty (2004), who regards it as 'the most important' and a manifestation of the brain's capacity for cross-model connectivity. Cross-modal metaphors and metonymic relationships enable the resonance of staccato sounds with the sharp edges in an image or the evocation of particular emotions.

When expressiveness increases from low levels, it signifies a heightened engagement with the experienced situation, leading to a greater potential for empathic and prosocial responses (Roberts & Strayer, 1996). Empathic responses are closely tied to the observation of others' actions, and expressive and empathetic traits are inherently interconnected. The emerging simulation theory incorporates mental models and communicative emotions positing that viewers' perceptions generate iconic models of their emotional experiences. When these models or processes simulate aspects of human emotions, audiences can also undergo those emotions (Johnson-Laird & Oatley, 2021). This theory asserts that the quality of the artist's movements during the creation of a work significantly impacts empathy engagement through active simulation.

Traditional animations, once created through stop-motion techniques, have been swiftly replaced by the advancements of 3D computer technology-based animation effects (Boulos, 2016). In the realm of art, expression entails the conveyance of emotions and sentiments during the creative process of producing an artwork. Artistic expressiveness is the artist's channeling of their unique emotions, emotions that hold the power to shape values and attitudes. This emotional surge is often catalyzed by the artist's interactions with their surrounding environment. The artist's creative journey yields works of art distinguished by their sensory beauty, capable of eliciting specific emotions in the viewer (Yunus, 2020). Pixar remains at the forefront of technology development in the production of 3D computer graphics animation. Pixar's exploration of textures represents a more expressive aesthetic than what has previously been achieved in digital animation (Haswell, 2014).

The film industry has witnessed significant advancements in production technology, enhancing its appeal. One crucial breakthrough in this regard is the incorporation of special effects. In live-action animation, the utilization of puppets has proven instrumental for filmmakers seeking to introduce a diverse array of animated characters into their productions. Puppetry sparks the creativity of filmmakers, enabling the creation of life-sized characters that appear as natural as possible. The movements and transitions between scenes in puppetry can serve as a source of inspiration for the development of distinct animation and characters. This is because both share a common essence as moving visual media. An illustrative example is the animated film *Die Abenteuer des Prinzen Achmed* (1926), the oldest animated film by the German animator Lotte Reiniger. Despite its age, the film stands out for the unique animation techniques employed by Reiniger. She employed black silhouette characters set against a multicolored background. Each silhouette figure was meticulously cut out by hand and animated frame by frame. Reiniger's animation drew its inspiration from the shadow theater tradition that enjoyed popularity in China, Indonesia, and Turkey, making its way to Europe (especially France and Italy), in modified form in the eighteenth century (Palfreyman, 2013).

Emotional realism differs from visual realism in the realm of computer technology. Visual realism pertains to the degree to which an image appears to the viewer as a computer-generated photograph. Establishing visual realism is a crucial and formidable task for computer graphics enthusiasts and the visualization community. Image realism serves as a metric for assessing and evaluating images in computer graphics and during the process of adjusting the level of realism using computer technology. Image realism can also find applications in content-based image analysis and image forensics. The film *The Blair Witch Project* succeeded in portraying fiction in a manner that engages the audience on an innate level. Achieving this requires the abandonment of conventional cinematic techniques and the meanings they conventionally represent. Prosumer aesthetics are employed as a criterion based on merit rather than focusing on emotional realism or visual realism, signifying the quest for 'truth' and the viewer's commitment to investing in the narrative's authenticity (Lam, 2014).

Evidence of technological progress in computer graphics features is evident through the production of 3D animated films by renowned animation studio. Table 1 presents the key milestones for the top 10 animation companies in the last decade. Walt Disney achieved a significant milestone with *Big Hero 6* (2014), making the first *Marvel* animated film to secure an Oscar win. Disney introduced its proprietary animation software, *Hyperion,* with the aim of creating top-tier animated films. The producers at Walt Disney Animation opted for cutting-edge software technology to craft the visual animation for *Big Hero 6*. Pixar Studio's *Wall-E* (2009) also made waves in the industry, earning an Oscar nomination for sound and music, along with the ultimate prize for Best Animated Feature. Meanwhile, DreamWorks released *How to Train Your Dragon 2* (2014), which won a Golden Globe Award for Best Animated Feature Film in the 2016 edition. Director Dean DeBlois highlighted one key difference between old and new animation methods, such as the handling of arching eyebrows. In older programs, animators had to select the eyebrows from a menu, specify the desired degree of curvature, and wait for the rendering process to conclude. The advent of tools like *Premo* and *Torch* allowed animators to manipulate characters in real-time using a stylus and a touch-screen monitor. However, it is essential to acknowledge that 3D computer graphics possess a modular, object-oriented nature, which can introduce challenges and counterintuitive aspects when dealing with 3D metamorphosis, numerical inversions, and distortion effects. In other words, computer graphics technology lacks the simplicity of traditional pen and ink methods.

Table 1: Animation companies key milestones (2013–Present)

Animation Company	Key Milestones	
	2013–2018	**2019–Present**
Pixar Animation Studios	Monsters University (2013) Inside Out (2015) Finding Dory (2016) Cars 3 (2017) Incredibles 2 (2018)	Onward (2020) Soul (2020) Luca (2021) Turning Red (2022) Lightyear (2022)
Walt Disney Animation Studios	Frozen (2013) Big Hero 6 (2014) Zootopia (2016) Moana (2016) Frozen II (2018)	Raya and the Last Dragon (2020) Encanto (2021)
DreamWorks Animation	The Croods (2013) How to Train Your Dragon 2 (2014) Home (2015) Kung Fu Panda 3 (2016) The Boss Baby (2017)	How to Train Your Dragon: The Hidden World (2019) Trolls World Tour (2020) The Boss Baby: Family Business (2021)
Studio Ghibli	The Wind Rises (2013) The Tale of the Princess Kaguya (2014) When Marnie Was There (2016)	Ghibli Park (2020) Earwig and the Witch (2021)
Illumination Entertainment	Despicable Me 2 (2013) Minions (2015) The Secret Life of Pets (2016) Despicable Me 3 (2017)	The Secret Life of Pets 2 (2019) Minions: The Rise of Gru (2021)
Blue Sky Studios (owned by Disney)	Epic (2013) Rio 2 (2014) The Peanuts Movie (2015) Ferdinand (2017)	Spies in Disguise (2019) The Ice Age Adventures of Buck Wild (2021)
Aardman Animations	Shaun the Sheep Movie (2015) Early Man (2018)	A Shaun the Sheep Movie: Farmageddon (2019)
Laika Studios	The Boxtrolls (2014) Kubo and the Two Strings (2016)	Missing Link (2019)
Warner Bros. Animation	The LEGO Movie (2014) Storks (2016) The LEGO Batman Movie (2017) Teen Titans Go! To the Movies (2018)	Scoob! (2020) Tom and Jerry (2021)
Cartoon Network Studios	Regular Show: The Movie (2015) The Powerpuff Girls Movie (2016)	Steven Universe: The Movie (2019) Adventure Time: Distant Lands (2020–2021)

Source: Compiled by authors from various internet databases

6. ONE-POINT PERSPECTIVE TECHNIQUE

The atmosphere of the animated scene, after corresponding technological processing, not only evokes excitement but also effectively highlights the characters within the scene, enabling viewers to experience the

animation with greater impact. In some animated sequences, fisheye lenses are employed to narrate the story. Fisheye lenses provide ultra-wide-angle perspectives (Ni, 2020). All theories regarding perspective are artistic techniques aimed at creating the illusion of three-dimensionality (depth and space) on two-dimensional (flat) surfaces. This perspective is what imbues a painting with shape, depth, and a sense of being "real" (Nafsika & Soeteja, 2021). Whether real or imagined, objects crafted by artists on a flat surface generate a sense of perspective when viewed by an observer. This concept of perspective is employed to represent objects that are relatively close to the viewer. When the viewpoint narrows, focusing on nearby objects, it results in these objects converging at a single vanishing point. However, replicating such a perspective in 3D animation, akin to painting on a 2-dimensional surface or paper, is a complex task. In this context, computer graphics introduces the one-point perspective feature. One-point perspective facilitates the creation of 3D images with ease and speed, where objects recede into the distance, mirroring real-life scenarios. This mathematical feature substitutes a 3D image onto a 3D surface by employing intersecting lines that converge at a distant point. These lines encompass the horizon line, a series of straight lines, and vanishing points. Artists can use these lines to produce intricate and lifelike representations of 3D images through a few straightforward steps.

The first textbook elucidating the fundamentals of perspective was published in 1492. Prior to this publication, several texts on the subject had been written. The art of drawing was considered a scientific endeavor applied to elucidate the natural laws. Albrecht Dürer's woodcuts include depictions of a drawing tool referred to as the "Leonardo box", named after Leonardo da Vinci. This tool was a perspective device employing a frame with a square grid to accurately depict a linear perspective when an artist worked on a surface featuring the same grid. By utilizing this method, the artist could ensure that all drawn lines accurately represented the object in the correct center perspective position. One-point perspective remains an abstract style that is still frequently used when depicting scenes from a naturalistic viewpoint. Nevertheless, experimental evidence suggests that cultural learning is not a prerequisite for understanding perspective images (Ni, 2020). Conversely, the human visual system continues to rely on linear perspective as the primary technique for representing 3D animated scenes.

Stanley Kubrick is a renowned film director and an expert in film composition. Kubrick skillfully employs the compositional technique of one-point perspective in his work to elicit psychological reactions from the audience and immerse them in uncomfortable situations, as exemplified in *The Shining* (1980) (Kubrick, 1890) (see Figure 3). Many of Kubrick's films delve into violent themes or subjects that demand a sense of dramatic seriousness. By using one-point perspective and symmetry in numerous shots, Kubrick masterfully enhances the gravity of the content. He excels in directing the audience's focus to a specific point during lulls in the narrative, thus building anticipation and tension. In doing so, Kubrick creates an atmosphere of suspense and eager anticipation.

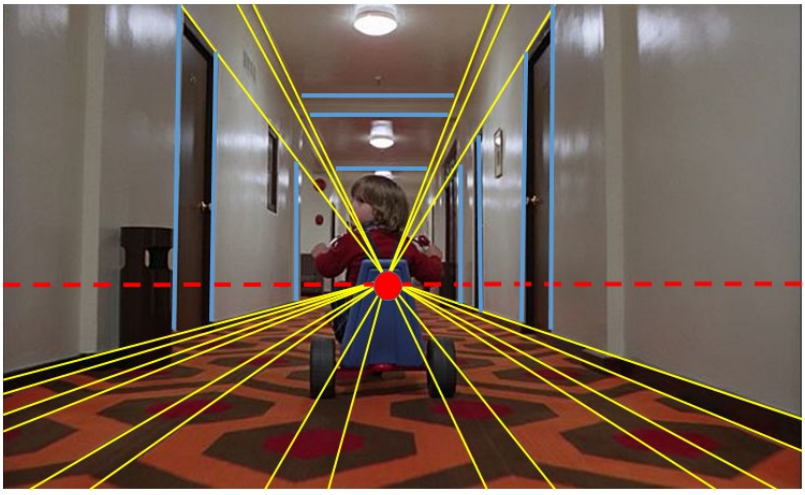

Figure 3: A scene from the movie *The Shining* featuring *a* horizon line (red), vanishing lines (yellow), and vertical lines (blue) (Kubrick, 1890)

Alternative projection techniques are not limited to the realm of ancient and modern art; they have also found their place in mainstream animation. These techniques can serve as both a distinctive artistic style and a practical guide for creating various foreground and background characters in animation. Non-photorealistic rendering (NPR) techniques are particularly valuable for bringing artistic visions to life in animation, decoration, illustration, and other formal aesthetic expressions. The choice of animation style is

typically influenced by factors such as the script, the theme of the work, and the director's artistic and ideological vision. Animation styles are commonly categorized into three main types: comprehensive realistic, cartoon and experimental types.

The creator of the *Maya* software tool and the R&D director for the groundbreaking film *Ryan* (2004), Karan Singh, is known for his innovative contributions to the world of animation. Singh's work has focused on developing interactive tools aimed at enhancing the creative process for animators and artists. His approach centers around the individual artist and combines interactive methods for geometric modeling and animation. One of Singh's significant achievements is the development of *Maya* as an interactive geometric model deformation tool, which has become a fundamental tool for kinematic animation. This software allows animation creators to more easily create, manipulate geometry, and interactively visualize their work. Furthermore, to expand the capabilities for 3D sketching and visualization, *Maya* provides the *ILoveSketch* system. This feature serves as a valuable source of inspiration for animation creators and artists, facilitating innovative and creative modeling through various interfaces that leverage sketches, scaffold-based construction, and guidance from drawings and 3D models.

7. NON-PHOTOREALISTIC RENDERING (NPR)

Rendering animation as we currently understand it, involves the three-dimensional rendering of images using patterns or textures to achieve a realistic appearance. Several factors contribute to making the rendering appear lifelike. The higher the level of detail in the rendered image, the closer it gets to pixel-perfect realism. In the context of animation and games development, rendering needs to be efficient to yield maximum accuracy quickly (Brainerd et al., 2016). However, striving for realism often requires a significant amount of time. This is where NPR with a cartoon-style approach comes into play. NPR can save both time and money while maintaining the essential aesthetics of the image, presenting a simpler yet visually engaging appearance (Benilov, 2015). NPR is a field within computer graphics that explores various expressive styles for digital art, drawing inspiration from traditional artistic styles like painting, freehand illustration, and cartoon animation.

The modeling process involves creating 3D models, whether they are character, objects, or entire environments. This is the initial step in the development of NPR. In recent decades, the computer graphics community has dedicated significant research efforts on NPR images and videos (Montesdeoca et al., 2018). Many rendering algorithms have been explored and developed, and rendering software has incorporated various techniques to produce the final image. Tracing every beam of light in a scene can be a laborious and time-consuming task. However, dealing with the complexity of photorealistic rendering in 3D animation presents another challenge. Researchers have been working to develop new techniques to improve rendering efficiency and address this problem.

NPR algorithms with temporal coherence have broad applications in computer graphics and virtual reality (VR) (Mills & Carter, 2017). Numerous NPR algorithms have been developed to enhance temporal coherence. Some of these algorithms leverage the geometric data of the model to maintain coherence, while others employ computer vision techniques to analyze the entire video sequence, achieving improved coherence. In early NPR techniques for VR and augmented reality (AR), each frame was typically rendered independently, without considering temporal coherence. This approach often resulted in flickering and distracting visual effects. NPR draws inspiration from various artistic styles, such as paintings, sketches, illustrations, and cartoon images, and applies them to movies and video games through techniques like toon shaders. Beyond toon shaders, NPR encompasses other areas of computer graphics, methods for transforming photographs into painting-like, sketches-like, and cartoon-style image, as well as caricature generation. When discussing the applications of NPR, the focus is on creating more artistic environments. As stated by Patil and Raman (2016), non-photorealistic images can be more effective in conveying information, more expressive, or more aesthetically pleasing. Virtual objects should appear more convincing than merely realistic. Therefore, expressive rendering must incorporate features that can enhance artistic effects, thereby presenting a challenge for animators and artists to showcase more refined expressive style.

8. CONCLUSION

Animation has become ubiquitous in our modern world. It can be found on billboards, mobile phone screens, and websites in the form of animated GIFs. Special effects driven by animation have become a staple in action, sci-fi, and fantasy films. Stereoscopic filmmaking is no longer experimental but rather a common practice. Interactive animation has thrived in the form of computer games. 3D technology in computing extends far beyond animated films and games. It finds applications in various fields, including medical simulations for

training, military aircraft operation, and educational simulations for processes in physics, chemistry, and biology. Furthermore, 3D technology, like VR, allows individuals to experience an unreal world designed for specific purposes. VR not only provides users with visual immersion but also creates the sensation of being physically present within these artificial environments.

The realm of photorealism in painting sometimes intersects with a more expressive variant known as hyperrealism, which can create terminology confusion. The style of illustration influenced by linear perspective has strong ties to the culture of film animators. Animators from Asian countries, including Japan, China, and Indonesia, often utilize oblique parallel projections in their works. The culture of naturalism has propelled the growth of 3D animation, particularly with the advent of live-action animation that relies on SFX technology. Production techniques using 3D computer graphics are currently highly adaptable and cost-effective. Hybrid aesthetics, which combine digitally created 3D computer graphics with live action and other animation techniques, provide a way to express animation visuals more dynamically. As technology advances, there is an increasing focus on innovation, and CGI technology has emerged as a strong driver of this innovative concept. However, numerous challenges and issues remain to be addressed in the pursuit of photorealism in CGI. Looking ahead, technological developments will play a crucial role in the ongoing evolution of expressive aesthetics in 3D animation.

REFERENCES

Abdullah, A. O., Muhammed, F. K., Zheng, B., & Liu, Y. (2018). An overview of computer aided design/computer aided manufacturing (CAD/CAM) in restorative dentistry. *Journal of Dental Materials & Techniques, 7*(1), 1–10. https://doi.org/10.22038/jdmt.2017.26351.1213

Abrams, M. H. (1953). *The mirror and the lamp: Romantic theory and the critical tradition*. Oxford University Press.

Adamson, A. (Director), & Jenson, V. (Co-director). (2001). *Shrek* [Film]. DreamWorks Animation.

Ahearn, L. (2014). 3D game textures: Create professional game art using photoshop (4th ed.). CRC Press.

Alliez, P., Meyer, M., & Desbrun, M. (2002). Interactive geometry remeshing. *ACM Transactions on Graphics, 21*(3), 347–354. https://doi.org/10.1145/566654.566588

Bak, M. A. (n.d.) *The humpty dumpty circus: Toward an expanded conception of toy cinema and cinema toys.* https://www.meredithabak.com/the-humpty-dumpty-circus

Bancroft, T. (Director), & Cook, B. dir (Co-Director). (1998). *Mulan* [Film]. Walt Disney Pictures.

Beneš, J., Kelly, T., Děchtěrenko, F., Křivánek, J., & Müller, P. (2017). On realism of architectural procedural models. *Computer Graphics Forum, 36*(2), 225–234. https://doi.org/10.1111/cgf.13121

Benilov, P. (2015). *Non photorealistic techniques with focus and context volume rendering* [Doctoral dissertation, Trinity College Dublin]. https://publications.scss.tcd.ie/theses/diss/2015/TCD-SCSS-DISSERTATION-2015-071.pdf

Bericat, E. (2012). Emotions. *Sociopedia.isa*, 1–13.

Berisha-Shaqiri, A., & Berisha-Namani, M. (2015). Information technology and the digital economy. *Mediterranean Journal of Social Sciences, 6*(6), 78–83. https://doi.org/10.5901/mjss.2015.v6n6p78

Biehler, J., & Fane, B. (2014). *3D printing with autodesk: Create and print 3D objects with 123D, AutoCad and inventor*. Que Publishing.

Boulos, D. N. (2016). Abstraction and stylized design in 3D animated films: Extrapolation of 2D animation design. In N. Lee (Ed.), *Encyclopedia of computer graphics and games* (pp. 1–11). Springer. https://doi.org/10.1007/978-3-319-08234-9_58-1

Brainerd, W., Foley, T., Kraemer, M., Moreton, H., & Nießner, M. (2016). Efficient GPU rendering of subdivision surfaces using adaptive quadtrees. *ACM Transactions on Graphics, 35*(4), Article 113. https://doi.org/10.1145/2897824.2925874

Brinck, I. (2018). Empathy, engagement, entrainment: The interaction dynamics of aesthetic experience. *Cognitive Processing, 19*(2), 201–213. https://doi.org/10.1007/s10339-017-0805-x

Chan, H.-P., Hadjiiski, L. M., & Samala, R. K. (2020). Computer-aided diagnosis in the era of deep learning. *Medical Physics, 47*(5), e218–e227. https://doi.org/10.1002/mp.13764

Chen, L., & Li, L. (2016). Optimization of animation curve generation based on hermite spline interpolation. *International Journal of Multimedia and Ubiquitous Engineering, 11*(5), 337–344.

Chen, W.-M., Cheng, S.-W., Hsiu, P.-C., & Kuo, T.-W. (2015). A user-centric CPU-GPU governing framework for 3D games on mobile devices. In D. Rolf, D. Azadeh, & W. Yu (Eds.), *2015 IEEE/ACM International Conference on Computer-Aided Design, ICCAD 2015* (pp. 224–231). Institute of Electrical and Electronics Engineers Inc. https://doi.org/10.1109/ICCAD.2015.7372574

Collingwood, R. G. (1938). *The principles of art*. Clarendon Press.

Couto, N., & Indrayuda. (2012). *Pengantar Sosiologi Seni* [Introduction to the Sociology of Art]. UNP Press. [in Indonesian]

Crafton, D. (1993). *Before Mickey: The animated film 1898-1928*. University of Chicago Press.

Dib, H., & Adamo-Villani, N. (2014). Serious sustainability challenge game to promote teaching and learning of building sustainability. *Journal of Computing in Civil Engineering, 28*(5), Article A4014007. https://doi.org/10.1061/(ASCE)CP.1943-5487.0000357

Dodworth, C. (2019). Impressions on the evolution of naturalism: Interiority, exteriority, and the international/interdisciplinary nature of naturalism. *Humanities*, *8*(3), Article 128. https://doi.org/10.3390/h8030128

Doyle, A. C. (1998). *The lost world*. Oxford University Press.

Duke, D. J., Barnard, P. J., Halper, N., & Mellin, M. (2003). Rendering and affect. *Computer Graphics Forum, 22*(3), 359–368. https://doi.org/10.1111/1467-8659.00683

Fan, S., Ng, T.-T., Koenig, B. L., Herberg, J. S., Jiang, M., Shen, Z., & Zhao, Q. (2018). Image visual realism: From human perception to machine computation. *IEEE Transactions on Pattern Analysis and Machine Intelligence, 40*(9), 2180–2193. https://doi.org/10.1109/TPAMI.2017.2747150

Fielding, R. (Ed.). (1967). *A technological history of motion pictures and television: An anthology from the pages of the journal of the society of motion picture and television engineers*. University of California Press.

Glazer, T. (2017). The semiotics of emotional expression. *Transaction of the Charles S. Peirce Society, 53*(2), 189–215. https://doi.org/10.2979/trancharpeirsoc.53.2.02

Global 3D animation market - trends, COVID-19 impact and growth forecasts to 2029. (2022, May 23). AgileIntel Research. https://www.agileintelresearch.com/reportdetails/Global-3D-Animation-Market/37

Glotov, S. (2022). Virtual production in The Lion King (2019): Formal and stylistics presentation. *Novos Olhares, 11*(2), 153–160. https://doi.org/10.11606/issn.2238-7714.no.2022.205340

Gong, Y. (2021). Application of virtual reality teaching method and artificial intelligence technology in digital media art creation. *Ecological Informatics, 63*, Article 101304. https://doi.org/10.1016/j.ecoinf.2021.101304

Güdükbay, U., & Durupınar, F. (2008). Three-dimensional scene representations: Modeling, animation, and rendering techniques. In H. M. Ozaktas & L. Onural (Eds.), *Three-dimensional television: Capture, transmission, display (signals and communication technology)* (pp. 165–200). Springer. https://doi.org/10.1007/978-3-540-72532-9_6

Ha, A. (2019, July 31). How the new 'Lion King' came to life. Behind the scenes of a 'virtual' movie production. *TechCrunch*. https://techcrunch.com/2019/07/30/lion-king-behind-the-scenes/

Hankin, M. (2008). *Ray Harryhausen-Master of the Majicks vol. 2: The American films*. Archive Editions.

Haswell, H. (2014). To infinity and back again: Hand-drawn aesthetics and affection for the past in Pixar's pioneering animation. *Journal of Film and Screen Media, 8*, 24–40. https://doi.org/10.33178/alpha.8.02

Ishii, K. (2013). Nationalism and preferences for domestic and foreign animation programmes in China. *International Communication Gazette, 75*(2), 225–245. https://doi.org/10.1177/1748048512459148

Jacquette, D. (2014). Art, expression, perception and intentionality. *Journal of Aesthetics and Phenomenology, 1*(1), 63–90. https://doi.org/10.2752/20539339XX14005942183973

Johnson-Laird, P. N., & Oatley, K. (2021). Emotions, simulation, and abstract art. *Art & Perception, 9*(3), 260–292. https://doi.org/10.1163/22134913-bja10029

Joon, J. S. (2010). Principles of Photorealism to develop photorealistic visualisation for Interface Design: A review. In E. Banissi, M. Sarfraz, & L. M. Huang (Eds.), *Proceedings - 2010 7th International Conference on Computer Graphics, Imaging and Visualization, CGIV 2010* (pp. 17–25). IEEE Computer Society. https://doi.org/10.1109/CGIV.2010.12

Jou, B., Bhattacharya, S., & Chang, S. F. (2014). Predicting viewer perceived emotions in animated GIFs. In J. Alejandro, S. Nicul, & B. Nozha (Eds.), *Proceedings of the 2014 ACM Conference on Multimedia* (pp. 213–216). Association for Computing Machinery. https://doi.org/10.1145/2647868.2656408

Kosmadoudi, Z., Lim, T., Ritchie, J., Louchart, S., Liu, Y., & Sung, R. (2013). Engineering design using game-enhanced CAD: The potential to augment the user experience with game elements. *Computer-Aided Design, 45*(3), 777–795. https://doi.org/10.1016/j.cad.2012.08.001

Kubrick, S. (Director). (1890). *The Shining* [Film]. Warner Bros.

Lam, C. (2014). Emotional realism and actuality: The function of prosumer aesthetics in film. *IAFOR Journal of Media, Communication & Film, 2*(1), 87–101.

Laverty, A. (Writer & Producer). (2004, September 30). Derek Tastes of Earwax (Season 41, Episode 13) [Television series episode]. In A. Laverty (Executive Producer), *Horizon*. BBC.

Leen, D., Ramakers, R., & Luyten, K. (2017). StrutModeling: A low-fidelity construction kit to iteratively model, test, and adapt 3D objects. In G. Krzysztof, M. Jennifer, & H. Chris (Eds.), *UIST 2017 - Proceedings of the 30th Annual ACM Symposium on User Interface Software and Technology* (pp. 471–479). Association for Computing Machinery, Inc. https://doi.org/10.1145/3126594.3126643

Li, Y. (2021). Film and TV animation production based on artificial intelligence AlphaGd. *Mobile Information Systems, 2021*, Article ID 1104248. https://doi.org/10.1155/2021/1104248

Limano, F. (2019). Realistic or iconic 3D animation (adaptation study with theory uncanny valley). In H. Rijal, R. Fransiska, & D. Njoo (Eds.), *ICSECC 2019 - International Conference on Sustainable Engineering and Creative Computing: New Idea, New Innovation, Proceedings* (pp. 36–41). Institute of Electrical and Electronics Engineers Inc. https://doi.org/10.1109/ICSECC.2019.8907103

Liu, L., & Stamos, I. (2005). Automatic 3D to 2D registration for the photorealistic rendering of urban scenes. In C. Schmid & S. C. Soatto (Eds.), *Proceedings - 2005 IEEE Computer Society Conference on Computer Vision and Pattern Recognition, CVPR 2005: Vol. II* (pp. 137–143). IEEE Computer Society. https://doi.org/10.1109/CVPR.2005.80

Lopes, D. M. (2005). *Sight and sensibility: Evaluating pictures*. Oxford University Press.

Michelle, C., Davis, C. H., Hight, C., & Hardy, A. L. (2017). The Hobbit hyperreality paradox: Polarization among audiences for a 3D high frame rate film. *Convergence, 23*(3), 229–250. https://doi.org/10.1177/1354856515584880

Mikki, S. (2021). Aesthetic theory and the philosophy of nature. *Philosophies, 6*(3), Article 56. https://doi.org/10.3390/philosophies6030056

Mills, P., & Carter, J. (2017). Unreal realities: Non-photorealistic rendering in virtual reality. In G. Tony, E. Seth, D.-B. Daniel, & P. Dale (Eds.), *Proceedings of CreateWorld 2017* (pp. 1–7). AUC.

Minkoff, R. (Director), & Allers, R. (Co-director). (1994). *The Lion King* [Film]. Buena Vista Pictures Distribution.

Montesdeoca, S. E., Seah, H. S., Semmo, A., Bénard, P., Vergne, R., Thollot, J., & Benvenuti, D. (2018). MNPR: A framework for real-time expressive non-photorealistic rendering of 3D computer graphics. *Expressive '18: Proceedings of the Joint Symposium on Computational Aesthetics and Sketch-Based Interfaces and Modeling and Non-Photorealistic Animation and Rendering,* No 9. https://doi.org/10.1145/3229147.3229162

Morton, R. (2005). *King Kong: The history of a movie icon from Fay Wray to Peter Jackson*. Applause Theatre & Cinema Books.

Nafsika, S. S., & Soeteja, Z. S. (2021). Learning innovation of constructive drawing in one point perspective subject. In Y. Sukmayadi, Z. S. Soeteja, T. Narawati, J. Masunah, R. Milyartini, & T. Nugraheni (Eds.), *Proceedings of the 3rd International Conference on Arts and Design Education (ICADE 2020)* (pp. 174–180). Atlantis Press. https://doi.org/10.2991/assehr.k.210203.037

Nathanson, J. (Writer), & Favreau, J. (Director). (2019, July 19). The Lion King. In *wdsmediafile.com*. Walt Disney Studios Motion Pictures.

Ni, B. (2020). Study on the Role of Scene Perspective in Animation Production. In G. Lukina, I. Rumbal, & Y. Zhang (Eds.), *Proceedings of the 4th International Conference on Art Studies: Science, Experience, Education (ICASSEE 2020)* (pp. 504–507). Atlantis Press. https://doi.org/10.2991/assehr.k.200907.089

Noheden, K. (2013). The imagination of touch: Surrealist tactility in the films of Jan Švankmajer. *Journal of Aesthetics & Culture, 5*(1), Article 21111. https://doi.org/10.3402/jac.v5i0.21111

Ovunc, S. S., Yolcu, M. B., Emre, S., Elicevik, M., & Celayir, S. (2021). Using immersive technologies to develop medical education materials. *Cureus, 13*(1), Article e12647. https://doi.org/10.7759/cureus.12647

Palfreyman, R. (2013). *Animal magic: Shape-shifting bodies in Lotte Reiniger's Die Abenteuer des Prinzen Achmed*. University of Nottingham.

Patil, A. G., & Raman, S. (2016). Automatic Content-aware Non-Photorealistic Rendering of Images. *ArXiv*, arXiv:1604.01962. https://doi.org/10.48550/ARXIV.1604.01962

Rahani, V. K., Vard, A., & Najafi, M. (2018). Claustrophobia game: Design and development of a new virtual reality game for treatment of claustrophobia. *Journal of Medical Signals and Sensors, 8*(4), 231–237. https://doi.org/10.4103/jmss.JMSS_27_18

Roberts, W., & Strayer, J. (1996). Empathy, emotional expressiveness, and prosocial behavior. *Child Development,* 67(2), 449–470. https://doi.org/10.2307/1131826

Robinson, J. (2005). *Deeper than reason: Emotion and its role in literature, music, and art*. Oxford University Press.

Robinson, J. (2017). The missing person found. Part I: Expressing emotions in pictures. *British Journal of Aesthetics, 57*(3), 249–267. https://doi.org/10.1093/aesthj/ayw076

Roopa, D., Prabha, R., & Senthil, G. A. (2021). Revolutionizing education system with interactive augmented reality for quality education. *Materials Today: Proceedings, 46*(9), 3860–3863. https://doi.org/10.1016/j.matpr.2021.02.294

Rysiew, P. (2016). *Naturalism in epistemology*. Stanford Encyclopedia of Philosophy.

Sheng, W. (2018). Research on the beauty of art animation. In G. Yongliang & L. Peidong (Eds.), *Proceedings of the 6th International Conference on Social Science, Education and Humanities Research (SSEHR 2017)* (Vol. 185, pp. 220–226). Atlantis Press. https://doi.org/10.2991/SSEHR-17.2018.52.

Shields, S. A., & Zawadzki, M. J. (2012). History of emotion theory. In R. W. Rieber (Ed.), *Encyclopedia of the history of psychological theories*, Part 19, 1088–1105. Springer. DOI: 10.1007/978-1-4419-0463-8_162

Tang, Y. M., & Ho, H. L. (2020). 3D modeling and computer graphics in virtual reality. In B. Sobota & D. Cvetković (Eds.), *Mixed reality and three-dimensional computer graphics* (pp. 69–76). IntechOpen. https://doi.org/10.5772/intechopen.91443

Taylor, P., & Potts, H. W. (2008). Computer aids and human second reading as interventions in screening mammography: Two systematic reviews to compare effects on cancer detection and recall rate. *European Journal of Cancer, 44*(6), 798–807. https://doi.org/10.1016/j.ejca.2008.02.016

Thies, J., Zollhöfer, M., & Nießner, M. (2019). Deferred neural rendering: Image synthesis using neural textures. *Acm Transactions on Graphics, 38*(4), 1–12.

Tormey, A. (2015). *The concept of expression: A study in philosophical psychology and aesthetics*. Princeton University Press.

Uhrig, M. (Ed.). (2018). *Emotion in animated films*. Routledge.

Wagner, K. B., & Jang, I. (2016). The 3-D animated codescape: Imperfection and digital labor zones in *Wall-E* (2008) and *Wreck-It Ralph* (2012). *Animation: An Interdisciplinary Journal, 11*(2), 130–145.

Wang, B., Chen, L., & Yang, B. (2022, August 15). *DM-NeRF: 3D scene geometry decomposition and manipulation from 2D images*. Cornell University. https://arxiv.org/abs/2208.07227

Wang, X., & Bi, Z. (2019). New CAD/CAM course framework in digital manufacturing. *Computer Applications in Engineering Education, 27*(1), 128–144.

Wedge, C. (Director), & Saldanha, C. (Co-director). (2002). *Ice Age* [Film]. 20th Century Fox.

Wilms, L., & Oberfeld, D. (2018). Color and emotion: Effects of hue, saturation, and brightness. *Psychological Research, 82*(5), 896–914. https://doi.org/10.1007/s00426-017-0880-8

Yunus, P. P. (2020). Aesthetic expressive communication of artworks. *Journal of Media and Communication Science, 3*(2), 70–77. https://doi.org/10.29303/JCOMMSCI.V3I2.77 [in Indonesian]

Zibrek, K., Martin, S., & McDonnel, R. (2019). Is photorealism important for perception of expressive virtual humans in virtual reality? *ACM Transactions on Applied Perception, 16*(3), Article 14.