The Impact of Virtual Technology on Film and Television Performance: a Paradigm Shift in Performance from Green Screen to Virtual Production

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Abstract: This paper investigates the impact of virtual technology on film and television acting, with a focus on the transition from traditional green screen methods to advanced virtual production techniques, such as LED screens and virtual reality. The study aims to understand how these innovations affect performance dynamics and the overall production process. Through qualitative analysis, including interviews with industry professionals and case studies of recent productions, the research examines how virtual technology enhances actor immersion and allows for greater versatility in performance across various media. Key findings suggest that while virtual environments offer actors increased flexibility and creative potential, they also pose challenges, such as limited interaction with physical sets and possible disruptions in actor-director communication due to the highly technical nature of the process. Despite these challenges, virtual technology is identified as a powerful tool for artistic innovation, paving the way for new possibilities in performance.

Keywords: Virtual Technology; Film and Television Acting; Virtual Production; Green Screen Technology; Immersive Experience; Acting Style; Cross-Media Acting

1. Introduction

The rapid development of virtual technology is profoundly transforming the production methods of the film and television industry, particularly in the field of acting, where virtual technology has introduced significant changes. Traditional film and television production relies on physical sets and green screen technology, where actors perform in a fabricated environment, and visual effects are added in post-production to merge virtual scenes and characters. Although green screen technology provides great flexibility in film production, it also presents certain limitations for actors[1]. When performing in front of a green screen, actors must rely heavily on their imagination to interact with invisible virtual surroundings, which not only requires strong spatial awareness and acting skills but can also diminish their sense of immersion and the authenticity of character portrayal[2]. Consequently, finding a balance between technology and performance has long.

With the rapid advancement of emerging technologies such as virtual reality (VR), augmented reality (AR), and motion capture, the application of virtual technology in film production has become increasingly common and advanced. Compared to traditional green screen technology, virtual production employs real-time rendering and LED display technology to create a more immersive performance environment for actors. Virtual production allows actors to perform within visually rich virtual environments, where they can interact with these surroundings in real-time, significantly enhancing the realism and engagement of their performances. For example, in the popular television series The Mandalorian, virtual production played a pivotal role by utilizing an innovative approach known as "StageCraft."This technique involved massive LED screens that displayed real-time, high-definition environments, allowing actors to perform within richly detailed landscapes without the need for traditional green screen setups. The actors could see and interact with the virtual settings, making their performances feel more authentic and reducing post-production efforts. This groundbreaking technology not only enhanced the visual quality of the series but

also streamlined the filming process, offering filmmakers more flexibility and creativity in shaping the show's immersive world.

The introduction of virtual technology also brings new challenges to film acting, in addition to its advantages. In highly technical production processes, acting methods are undergoing a profound transformation. Actors must not only overcome the challenges posed by performing in virtual environments but also adapt to the constraints of wearing motion capture devices and other wearable technologies, as well as the difficulty of blending virtual characters with live performances. In this context, actors are required not only to maintain the naturalness of their performance and the authenticity of their emotional expressions under technical conditions but also to collaborate closely with increasingly complex technological workflows. This elevated demand for acting skills encourages actors to re-examine their techniques

Virtual technology will undoubtedly continue to drive the development of film and television acting, possibly even redefining the boundaries of performance. As technology advances, virtual production is expected to extend beyond sci-fi films and high-budget blockbusters, becoming more widely adopted in various types of film and television productions, thereby altering the traditional modes of acting. Finding the optimal balance between virtual technology and the art of acting, and exploring how virtual technology can bring more creativity and possibilities to performance, will become key topics in the future development of the film industry. By exploring the impact of virtual technology on film and television acting, this paper aims to provide a comprehensive perspective on this transformation, analyzing how virtual production is changing the form, methods, and future trajectory of film acting.

2. A Historical Review of Film and Television Acting and Technological Development

Film and television acting, as an art form, has undergone multiple technological transformations since its inception[3]. The earliest modes of acting in film and television primarily relied on location shooting and artificially constructed sets, emphasizing

actors' performances within real environments. In this traditional model, actors' performances were more natural as they could interact with the physical surroundings, creating authentic emotional expressions and physical reactions[4]. However, the limitations of location shooting included high production costs and a lack of diversity in available settings. This was particularly problematic for films that required extensive special effects or fantastical settings, as it was often impossible to create such visuals in reality. As technology advanced, the film industry began to incorporate more innovative techniques to improve production efficiency and expand the expressive potential of performances.

In the late 20th century, green screen technology (Chroma Key) became widely adopted in film production. The introduction of green screens brought both new challenges and opportunities to acting. This technology allowed directors to build only the most basic physical environments during filming, with virtual scenes added in post-production. For actors, green screen technology broke the limitations of physical sets, enabling them to be placed in a wide range of otherwise inaccessible environments, such as outer space, fantasy worlds, or historical ruins. However, green screen technology also placed higher demands on actors' performances. Since actors could not see or physically interact with the actual settings during filming, they had to rely heavily on their imagination and the director's guidance to interact with invisible objects or environments. This method of acting increased the psychological burden on actors, requiring them to undergo significant training to master the techniques of interacting with virtual environments. While green screen technology effectively expanded the visual scope of films, it also posed challenges to the naturalness of performances, and some audiences found the transition between virtual and real scenes to be jarring.

In the 21st century, the rise of virtual production technology further revolutionized film and television acting. Especially in works like The Mandalorian, virtual production technology demonstrated its immense potential to replace green screen technology. Virtual production utilizes real-time rendering and LED walls to display virtual environments directly on set, allowing actors to see and

interact with the environments in real-time. This technology creates a more authentic atmosphere for performances, reducing the actors' reliance on imagination and enhancing the immersion and naturalness of their acting. Unlike green screens, virtual production allows actors to improvise within virtual scenes, and directors and cinematographers can adjust the environments and camera angles in real-time, significantly improving shooting efficiency and production outcomes[5]. The Mandalorian's success has shown that virtual production technology not only enhances the visual impact of film and television works but also helps actors better immerse themselves in their roles, improving the overall viewing experience for audiences. As this technology continues to evolve, virtual production is poised to become the mainstream in the future of the film industry, completely transforming traditional acting methods.

3. The Transformation of Film Acting under Virtual Technology

3.1 The Impact of Virtual Technology on the Sense of Space in Acting

The advent of virtual technology, particularly through LED screens and virtual reality (VR), has fundamentally altered the way actors experience and interact with their environments on set[6]. Traditional film production required actors to perform in physical locations or against constructed sets, offering them tangible elements to engage with. In contrast, virtual production often involves fully digital or semi-digital environments, where actors must navigate a space that may not physically exist. Virtual production, powered by LED walls, allows actors to see highly detailed digital landscapes in real-time, offering an enhanced sense of spatial awareness that green screen technology previously could not provide. This creates a hybrid environment where the line between the real and the virtual becomes blurred. The actors are no longer simply imagining their surroundings; they can see and react to digital landscapes that mirror the intended final product.

The shift to performing in such digitally enhanced settings presents its own challenges[7]. The virtual environments may offer visual cues, but they still lack the tactile feedback and physical interactions actors are accustomed to. For example, an actor standing on a digitally rendered cliff may visually perceive the drop but lacks the sensory experience of wind or height that would naturally influence their physical reactions. This alters how actors perceive space and interact within it, challenging their ability to maintain authentic body language and reactions. The virtual environment must therefore offer actors enough sensory stimuli to maintain a performance grounded in realism, all while encouraging an adaptable sense of movement within the scene.

3.2 Adjustments in Acting Techniques for Virtual Technology

As virtual technology becomes increasingly prevalent in film production, actors must adjust their techniques to perform effectively within these highly technical environments. In traditional film sets, actors interact with physical objects and sets, which ground their performances in reality. However, in virtual production, actors often perform in environments where much of the scenery is added digitally in post-production. In some cases, actors may be working in almost empty sets, where markers or rudimentary props stand in for intricate settings or other characters, requiring them to rely heavily on imagination.

This shift demands a significant adaptation in performance style. Without the presence of physical objects, actors must mentally visualize the environment around them while reacting convincingly to things that do not yet exist. They must also adjust their eye lines, body movements, and spatial awareness to ensure that their actions are in sync with the digital environment that will be added later[8]. These adjustments require intense concentration and often involve close collaboration with the director and visual effects teams. Directors play an increasingly essential role in guiding actors, helping them to navigate through unfamiliar and ever-changing landscapes, while also ensuring that their performances align with the envisioned final product.

Emotional expression can become more complex in virtual environments. Acting is an art rooted in interaction—not only with other characters but also with the setting. In virtual

productions, the absence of real objects or fully developed sets can create a sense of detachment, making it harder for actors to immerse themselves in the moment. Therefore, actors must develop new strategies to evoke emotions and convey authenticity even when interacting with largely imagined elements. This adjustment of technique requires an increased reliance on an actor's ability to remain emotionally present and deliver a performance that feels grounded, despite the virtual nature of their surroundings.

3.3 The Relationship between Virtual Production and Actor Psychology

The psychological state of actors working in virtual environments also undergoes significant transformation[9]. Acting within virtual production settings can create a disconnect between the performer and the environment, leading to potential challenges in sustaining emotional engagement. Traditional sets often aid actors in feeling immersed in the story by surrounding them with the physical world of the character. In contrast, virtual environments can feel more sterile or alienating, where the actor is more aware of the artificiality of their surroundings. This can disrupt an actor's ability to remain emotionally grounded, particularly when trying to convey subtle nuances in emotional expression.

Virtual production also presents opportunities for actors to explore new dimensions of performance. By reducing the constraints of physical settings, actors are free to focus more on their craft rather than adapting to the limitations of practical sets[10]. The LED walls used in virtual production, for instance, allow actors to inhabit expansive environments with lifelike visuals, which can be particularly stimulating and emotionally engaging. As virtual production tools evolve, actors are increasingly provided with visual feedback that can deepen their psychological immersion in the scene. For example, seeing a fully rendered alien landscape or a distant battlefield in real-time can enhance an actor's ability to engage with the imaginary elements of the scene, leading to more authentic performances. Additionally, virtual production creates new psychological demands for actors, especially in terms of sustaining concentration and energy. Filming in these environments can often feel more fragmented, with multiple technical aspects influencing how scenes are shot and requiring greater patience and flexibility from performers. Actors may experience longer wait times between takes as the virtual production elements are calibrated, making it more challenging to maintain the emotional intensity necessary for their role. These conditions force actors to adapt their psychological approach, learning to compartmentalize their focus and channel emotional responses on demand, even when the environmental cues are lacking.

Ultimately, the integration of virtual technology in film and television acting challenges actors to explore new methods of performance, creating both obstacles and opportunities. The lack of physical interaction and the reliance on imagination can test an actor's ability to convey naturalism, while the immersive potential of virtual environments offers new ways to inhabit characters and stories. This balance between technical precision and emotional depth defines the future of acting in virtual settings, pushing actors to continuously evolve their craft in the face of technological advancements.

4. Innovations in Acting Methods Brought by Virtual Technology

4.1 Real-Time Feedback and Interactivity

One of the most transformative aspects of virtual production is the real-time feedback and interactivity between actors and their environments. In traditional green screen setups, actors perform in front of a blank background, with the visual elements added in post-production. This often requires actors to imagine their surroundings, relying heavily on direction and mental visualization. In contrast, virtual production environments, particularly those utilizing LED screens, allow actors to see the rendered backgrounds in real-time. This immediate visual feedback fundamentally enhances the authenticity of the performance, as actors can respond naturally to their surroundings.

For instance, in scenes involving dynamic environments, such as a shifting landscape or an approaching storm, actors can witness these changes as they happen on the LED screens. This not only allows them to react more convincingly but also helps them stay grounded in the scene, creating a stronger

emotional connection to the setting. The interactive nature of virtual production also extends to lighting and atmosphere. LED screens can simulate various lighting conditions—such as the glow of a sunset or the flicker of a fire—which helps actors adjust their expressions and body language in response to the changing environment. This real-time interplay between the actor and the virtual backdrop bridges the gap between digital and practical effects, producing performances that feel more organic and immersive.

This technology enables directors to make immediate adjustments to the environment during filming. For instance, if an actor needs to interact with a digital object, the visual effects team can modify its position or appearance in real-time, allowing the actor to adapt their performance instantly. This level of interaction and flexibility offers new creative possibilities and helps reduce the disconnect that often occurs between the actor and the post-production team in traditional filmmaking.

4.2 The Transformation of Physical Performance

Another key innovation brought by virtual technology is the use of motion capture (mocap) systems, which has significantly transformed how actors approach physical performance. Motion capture technology allows actors to embody digital characters by wearing specialized suits that track their movements. This data is then applied to computer-generated characters in real-time or during post-production, enabling actors to breathe life into animated or fantastical figures.

One of the main challenges for actors using motion capture technology is the absence of traditional costumes, props, and sets. Actors must rely on their body movements to convey the essence of their character, as their facial expressions and gestures are often the only link between the actor and the digital figure being portrayed. Despite the restrictive nature of wearing motion capture suits, which can sometimes hinder movement, actors are expected to deliver fluid, natural performances that align with the physical characteristics of the digital character.

For example, in films like Avatar and The Planet of the Apes series, actors used motion capture suits to perform as alien or animal characters. These performances required a deep understanding of body language, as the actors had to simulate non-human movements while maintaining the emotional core of the characters. This blending of physical acting with digital creation has expanded the range of roles available to actors, allowing them to portray characters that would otherwise be impossible to depict through traditional means. The real-time nature of modern motion capture systems enables actors to see their digital counterparts in action during performance. This gives them a sense of how their movements translate to the virtual character, allowing for immediate adjustments to improve the performance. As a result, actors are better equipped to strike a balance between exaggerated physicality—necessary for certain fantasy characters—and maintaining the subtlety and nuance required for believable emotional expression.

4.3 The Fusion of Virtual and Realistic Acting

Virtual production technology seamlessly merges acting with digital effects, allowing performances to be integrated into highly complex and often otherworldly environments. This fusion of virtual and real elements is particularly relevant in genres such as science fiction and fantasy, where actors frequently interact with non-existent or highly stylized settings. The challenge lies in maintaining the authenticity of the character's emotions and reactions while navigating these unreal environments.

In virtual production, actors are not just performing in a vacuum; they must deliver performances that resonate with audiences, even when much of their surroundings and interactions are created digitally. This requires a high level of adaptability, as actors must be able to respond to stimuli that may not be physically present on set[11]. Virtual technology assists in this process by creating more immersive environments that enhance the believability of the actor's performance. For example, an actor playing a character on an alien planet might be surrounded by digitally rendered landscapes on LED screens, allowing them to fully inhabit the character's reality without breaking the emotional

continuity of the scene.

The fusion of virtual and real acting is also evident in how actors engage with digital co-stars, such as computer-generated creatures or robots. In films like Avengers: Endgame and Star Wars, actors often perform alongside virtual characters that will only be fully realized during post-production. Despite the absence of physical interaction, the performances must still feel authentic, requiring actors to project emotional depth even in scenes involving entirely virtual characters. This blending of digital and live-action acting has become a key component of modern blockbuster filmmaking, demonstrating how virtual technology can enhance performance without detracting from the authenticity of the actor's craft.

Ultimately, the fusion of virtual technology and acting presents new opportunities for artistic expression, offering actors the ability to explore more diverse roles and settings. By combining real-time feedback, motion capture, and immersive virtual environments, actors can deliver performances that are both technically sophisticated and emotionally resonant. As virtual production continues to evolve, it will likely push the boundaries of what is possible in film and television acting, opening up new frontiers for creative collaboration between actors, directors, and digital artists.

5. The Diversification of Acting Styles through Virtual Technology

The rapid development of virtual technology has significantly enhanced the immersive experience of film acting. In virtual production environments with 360-degree panoramic views and highly realistic virtual scenes, actors no longer have to rely on imagination to perform. Instead, they can interact directly with the hyper-realistic digital environment. This immersive experience strengthens actors' ability to embody their characters, allowing them to form a deeper emotional connection with their surroundings. This technology not only enhances the authenticity of performances but also fosters diversification in acting styles. Actors can explore different performance styles within these virtual scenes, ranging from realism to fantasy genres, as the flexibility of virtual technology allows them greater freedom in performance exploration,

broadening their expressive abilities.

Another significant benefit brought by virtual technology is the possibility of cross-media acting. With virtual technology, the boundaries between film, television, and theater are gradually dissolving, allowing actors to shift between different media more freely. For example, actors can use virtual reality technology during theater rehearsals to pre-visualize complex scenes and then carry that performance into virtual film production. This cross-media performance not only expands the creative space for actors but also offers them more artistic opportunities, fostering greater diversity and innovation in their acting styles.

Additionally, virtual technology has opened new possibilities for globalization and cross-cultural performances. Through virtual production, actors can easily overcome geographical and linguistic barriers to participate in international projects. Virtual technology allows actors from different cultural backgrounds to collaborate within the same virtual setting, promoting cross-cultural performance exchanges. For actors, this means broader access to global audiences and opportunities to work on culturally diverse projects, further advancing the internationalization of acting.

6. Challenges and Future Development of Virtual Technology

Despite the many innovations virtual technology has brought to film acting, it also presents challenges, particularly concerning the naturalness of performances. In highly technical environments, actors' expressiveness may be limited. For instance, in scenes filled with digital effects, actors often rely on markers or digital references for performance, which can diminish the naturalness of their acting. The lack of physical elements in virtual scenes may also lead to less authentic emotional expressions compared to performances in traditional environments. Therefore, how to maintain the fluidity and authenticity of performances in virtual settings is an important issue that needs to be addressed moving forward.

Another challenge in virtual production is the potential communication barriers between actors and directors. As technical processes become more complex, the interaction

between directors and actors may be disrupted. Directors may rely more on feedback from the technical team rather than directly guiding the actors, increasing the difficulty of maintaining control over performances. Actors may feel that their communication with the director is not as direct or smooth as in traditional production environments, potentially affecting the quality of their performances. Thus, maintaining effective communication between actors and directors in highly technical virtual production environments is a critical issue to resolve.

Looking ahead, virtual technology will undoubtedly play an even more crucial role in film acting. The further integration of technology and performance will be a key trend, and balancing the relationship between technology and artistic expression in virtual environments will be a central issue for directors, actors, and technical teams alike. Virtual technology offers limitless creative possibilities while requiring actors to continually adapt to new technological environments. The future of acting will become more diverse, global, and will continue to explore the perfect fusion of technology and art.

7. Summary

The rapid development of virtual technology has significantly transformed film and television acting, enhancing immersion, performance authenticity, and the diversity of acting styles. With real-time feedback, virtual environments, and motion capture technology, actors can naturally express emotions and physical movements within virtual settings. However, these advancements also introduce new challenges and demands for acting techniques, training, and production processes. In the future, virtual technology will play an increasingly important role in driving innovation in the film industry and enhancing audience immersion experiences.

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