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Practical Application and Impact of VR (Virtual Reality) Technology in Animation Filmmaking

Qingwen Su[1], Zainatul Shuhaida Abdull Rahman[2]*, Ang Li[3], Arwin Ramli[4]
**Corresponding Author*

[1] College of Creative Arts, Universiti Teknologi MARA (UiTM) Shah Alam, Selangor, Malaysia
[2] Institut Seni Kreatif Nusantara (INSAN), Universiti Teknologi MARA (UiTM), Selangor, Malaysia
[3] Faculty of Architecture and Engineering, Jiangxi Polytechnic University, China
[4] Visual Communication Design, Institut Teknologi Batam, Indonesia

2022743723@student.uitm.edu.my, zainatul@uitm.edu.my, 514941661@qq.com, arwin@iteba.ac.id
Tel: +8618870928916

Abstract
This study explores the application of Virtual Reality (VR) technology in animated filmmaking, focusing on its impact on production processes and audience engagement. Using a qualitative case study of *Black Myth: Wukong*, the research examines how VR enhances planning, character modeling, animation, and post-production. The findings show that VR improves production efficiency and creative freedom and enables real-time rendering, transforming audience experiences from passive viewing to active participation. Despite its benefits, challenges such as hardware limitations and a steep learning curve hinder broader adoption. The study suggests that future research should explore VR's application across different animation genres and regions to further its integration in the industry.

Keywords: Virtual Reality, Animation Filmmaking, Real-Time Rendering, Interactive Narratives

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1.0 Introduction

Virtual Reality (VR) technology has marked a new epoch of change in the animation filmmaking industry. This includes novel approaches to conceptualizing, producing, and consuming animated films. VR technology is the backbone of an animation industry that is fundamentally changing due to the integration of immersive experiences. As many leaders in the field have recognized (Slater & Sanchez-Vives, 2016), VR is more than a tool of artistic representation; it also enhances productivity and fundamentally changes how the audience interacts with the production. Through its three-dimensional virtual plane, VR enables creators to reconsider the entire animation gamut, from initial planning to audience engagement in the animation process.

The use of VR technology in cinematic productions dates back to the 1960s with Morton Heilig's Sensorama, emphasizing its nearly limitless possibilities. Advanced commercial VR headsets and data gloves were later developed, allowing for more refined modern applications of VR technology (Cruz-Neira et al., 2018). Currently, devices like the Oculus Rift, HTC Vive, and PlayStation VR have made VR technology more affordable and accessible to the public, allowing for its use in mainstream media production, particularly in animated films.

The use of VR technology within films is mainly to improve production processes and enhance viewer experience. The purpose of this research is to analyze how VR technology is used in different stages of animation production, including but not limited to concept

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development, character model design, and animation (Lyu et al., 2024). Furthermore, it assesses how VR technology changes the audience experience from passive to active through case studies of its application, such as in *Black Myth: Wukong.* This understanding of VR is expected to contribute to the discussion on enhancing audience participatory experience through immersion in narrative films using VR in animation.

The objective of this research is to analyze the application of VR technology in various stages of animation production and to examine how VR transforms audience engagement by enabling immersive and interactive viewing experiences. VR technology addresses common production shortcomings by allowing designers to construct and examine storyboards in a three-dimensional theatre. Conventional production techniques frequently face difficulties visualizing intricate spatial relationships and dynamic effects with two-dimensional sketches. For example, VR produced *Black Myth: Wukong* to design virtual storyboards that enable real-time edits and scene previews, thereby increasing design accuracy and efficacy.

Additionally, VR's use in character modelling has transformed artistic freedom, as 3D representations of characters can now be meticulously worked on beyond the confines of 2D views. With motion capture systems, actors' movements are translated into animations that add to the models' realistic appearance (Zhang et al., 2020). Hence, artists can use VR technology to improve the detail and accuracy of the models created.

The use of VR technology filters down to audience engagement and post-production processes. In particular, VR technology enables real-time rendering and scene changes. This changes how a viewer experiences the film, moving from passive to active participation, which increases immersion and interactivity. One example is *The Walking Dead: Saints & Sinners,* where immersive VR gives the viewers the agency to interact with different characters and settings in real time, changing the direction of the story (Serr).

Reviews of the literature converge on the assumption that VR technology increases not only the efficiency and freedom of production work but also the artistry and involvement of the audience. Nevertheless, the use of VR in animated filmmaking is still limited by several constraints, such as the need for substantial processing power and a strong working knowledge of VR systems (Limited, 2024).

This research contributes to filling a gap by examining the specific roles that VR technology occupies within animated filmmaking, thus building a framework of what is possible. This research aims to validate how VR technology profoundly changes the animated film industry by providing alternative answers to its challenges. It showcases the improvement of VR technology in the entertainment industry through virtual storyboards, enhanced character detail, and interactive viewing. Additionally, the study seeks to inform how VR in the entertainment industry can evolve so that future strategic choices in film production can be achieved, steering the industry toward an inventive and engrossing VR-centered advancement.

2.0 Literature Review

2.1 Overview of VR in Animation: Benefits, Applications, and Challenges

The exploration of Virtual Reality (VR) in animation-specific contexts remains limited, despite its potential to revolutionize the field. VR offers immersive environments that can enhance the animation process by providing intuitive interfaces and improving spatial awareness. However, the integration of VR into animation is still in its early stages, with several challenges and areas yet to be fully explored. Current research highlights VR's benefits, applications, and limitations, which frame the direction and necessity of further studies in this area.

Recent studies have identified several potential advantages of integrating VR into animation workflows. For example, immersive VR environments support enhanced spatial awareness by allowing animators to experience the creative space more intuitively, in a real-world-like manner. This supports more effective spatial planning and enhances overall production efficiency (Sharma et al., 2023; Cannavò et al., 2019). Additionally, VR facilitates more natural and efficient interactions with animation tools, potentially reducing the complexity of tasks and the time required for completion. Beyond production efficiency, VR also shows promise in educational contexts, where it aids in visualizing complex 3D processes, suggesting its potential to transform animation training and pedagogy (Tang et al., 2020; Vundela & M., 2024).

While these benefits highlight VR's growing presence across various creative sectors, its application within animation production workflows—particularly in narrative development, character modeling, and viewer interaction—remains underexplored. VR is currently applied in several aspects of animation production. It plays a role in 3D animation design by enhancing interactivity and enabling real-time modifications. In film production, VR is increasingly used during the previsualization phase, assisting directors and animators in crafting visual sequences in an intuitive and immersive manner (Galvane et al., 2019). VR-based interfaces have also been developed for character animation tasks such as rigging, skinning, and posing, which have been shown to reduce task completion times without sacrificing accuracy (Cannavò et al., 2019). These developments underscore VR's growing integration into contemporary animation pipelines, although its adoption is still limited.

Despite these promising applications, several challenges continue to hinder the widespread adoption of VR in animation. Many VR animation tools replicate the complexity of traditional 3D software, creating a steep learning curve for new users (Gaarsdal et al., 2022). Moreover, the current limitations of VR hardware constrain its potential, especially in rendering high-quality, immersive environments that can meet the needs of professional animation (Romeiro et al., 2024). A significant obstacle also lies in the lack of research and development efforts specifically targeting the animation industry, which slows the creation of VR tools tailored for animation (Gaarsdal et al., 2022). These limitations illustrate why, despite its benefits, VR remains underutilized in mainstream animation production.

2.2 The Practical Application of VR Technology in Animated Film Production

The animation film sector has been experiencing advancements brought about by new technologies, tools, creation methods, and enhanced audience perspectives. In this regard, introducing VR technologies, which facilitate innovation in creativity and improve production efficiency, enhances the entire audience experience. This section analyzes the primary focuses of VR technology used in animated film production.

VR technology enables creators to transform their plans and storyboard production into a virtual environment. With the aid of VR, users can appreciate the aesthetics of a planner and assist in designing various scenes, lens angles, and character movements while seamlessly observing how the scenes are combined and transferred into the virtual environment. Using VR scene planning and rendering previews enables stage designers to view changes as they happen live. This makes it easier to design the scenes for shots during actual production—like putting together a jigsaw puzzle. Lyu et al. (2024) asserted that using VR in projects provided greater efficiency and accuracy in scene design during the planning phase, as the team members could appreciate the three-dimensional viewpoint of the game scenes.

The use of VR technology significantly increases the precision in character modelling and the quality of animation performance. Traditionally, character modelling was done with static models and views from two dimensions, which limits intricate changes and coordination. VR offers a three-dimensional environment, enabling detailed and intuitive character modelling. Models can be viewed from every angle, adjustments can be made in real time, and fine details can be optimized. Motion capture systems and VR enhance dynamic performance realism by capturing actors' movements and placing them on virtual characters. Animators use VR environments to view action in real time and adapt it for fluid animation. Character modeling in *Black Myth: Wukong* constantly employs VR, enabling precise detail adjustments for character animation, resulting in visually spectacular outcomes (Zhang et al., 2020).

Fig. 1: Application of VR technology in character modelling and animation production
(Source: ZCOOL, https://www.zcool.com.cn/work/ZNDc4NjYwMzY=.html?lng=en)

VR technology in real-time rendering and scene adjustment during post-production is invaluable. It allows creators to see how lighting, materials, and visual details are blended in the rendering and adjust them to maximize work efficiency while guaranteeing high output quality. Concerning audience experience, new modes of viewer interaction with the virtual world through VR are made possible. In animated films, creators can use immersive VR to add interactivity that motivates users to assist in advancing the story. This transforms traditional watching into an active invitation to discovery. For instance, in *Black Myth: Wukong*, VR technology allows audiences to actively participate by searching for hidden treasures, enhancing immersion and interactivity (He & Sun, 2024).

Fig. 2: VR technology is applied in Black Myth: Wukong
(Source: Game Science. (2023). Wukong VR performance test tool promotional image [Digital image]. Black Myth: Wukong Official Website. https://www.heishenhua.com)

2.3 The Influence of VR Technology in Animated Film Production

VR technology improves production efficiency through a virtual environment that can be accessed in real time, increasing creativity and collaboration. Traditional animation often relied on multiple 2D perspectives and static models, which proved suboptimal. Designers can now navigate virtual environments and manipulate designs in real time, drastically reducing reliance on conventional methods and shortening production cycles. These capabilities allow for more terrific refinement and innovation. This is well demonstrated in *Black Myth: Wukong*, where VR supported efficient scene design and collaborative workflows.

VR technology encourages creative leadership in new spatial and narrative visual effects. Older animations used static or less sophisticated techniques, limiting the complexity of visual storytelling. VR allows for creating and manipulating complex effects in real time, producing more vivid performances. Furthermore, narrative methods are enhanced through audience participation in non-linear, interactive storytelling—deepening narrative engagement and personalization, as seen in the VR film *The Rose and I*.

VR also transforms how audiences experience content. Unlike traditional viewing, VR enables real-time story engagement, expanding character interactions and allowing storytelling branches through interactive plot nodes. In *The Walking Dead: Saints & Sinners*, audience decisions directly impact the story, offering a tailored and emotionally engaging experience (Serrano et al., 2016). Similarly, *Black Myth: Wukong* incorporates VR elements that allow users to explore the narrative world and discover hidden content, enhancing engagement and immersion.

Fig. 2: The audience wears the virtual reality head to experience The Black Myth: The Monkey King

(Source: Game Science. (2023). Wukong VR performance test tool promotional image [Digital image]. Black Myth: Wukong Official Website. https://www.heishenhua.com.)

The influence of VR extends beyond technical applications and into creative storytelling. Traditional animation often relies on linear narrative structures and pre-rendered visuals, but VR enables non-linear, participatory storytelling that can adapt based on user interaction. These developments are supported by the presence theory, which suggests that immersive environments increase emotional and cognitive involvement by making users feel physically present within the story (Slater & Sanchez-Vives, 2016). By enhancing production and reception, VR creates new opportunities for narrative depth and artistic expression.

In conclusion, while VR holds significant potential to transform animation filmmaking, its full adoption is currently limited by technical, educational, and developmental barriers. Nonetheless, its ability to enhance production workflows, support creative freedom, and enrich audience engagement underscores the importance of continued research and innovation in this field. This review provides the foundation for the current study's objectives: to analyze how VR is applied in different stages of animation production and to examine how it reshapes audience engagement through immersive and interactive experiences.

3.0 Methodology

Using a qualitative approach, this paper investigates how Virtual Reality (VR) technology is used in animated film production and how it changes audience involvement. A qualitative method is appropriate because it allows for a deeper understanding of creative practices, production techniques, and user experiences—areas that cannot easily be measured with numbers alone. This approach enables the researcher to explore the nuanced and context-specific ways VR is integrated into artistic and technical workflows, as well as the subjective experiences of audiences. Since the study involves interpreting human behavior, technological interaction, and creative decision-making, quantitative methods would be insufficient to capture the depth and variability of these phenomena.

Qualitative analysis is accompanied by a detailed assessment of literature related to VR technology in film production, mainly focusing on existing research concerning the history, elements, and functioning of VR systems so that the context of the study is well-linked with the literature (Slater & Sanchez-Vives, 2016; Cruz-Neira et al., 2018). The study centers on *Black Myth: Wukong*, a pioneering animation project that actively integrates VR into its creative workflow and narrative design. This project offers a compelling and relevant case, providing real-world examples of how VR is used across multiple stages of animation.

3.1 Research Design

The research is structured as a case study, allowing an in-depth look at how VR is applied in a specific animated production. *Black Myth: Wukong* was selected because it is one of the few publicly documented projects demonstrating VR's use from pre-production to post-production. Its scale, creativity, and availability of behind-the-scenes content make it an ideal example for exploring production efficiency and interactive audience experience. The case study method is **justified** as it enables a focused exploration of a single, information-rich example, allowing the researcher to draw meaningful insights that may be transferable to similar creative and technological contexts. This approach aligns directly with the research objectives by examining how VR changes both the creative process and how audiences experience animated content.

3.2 Data Collection

To support the research objectives, data was gathered from three primary sources:

- Industry Interviews: Conversations with professionals working in VR-supported animation provide insight into how VR influences production workflows, creativity, and decision-making across different stages.
- Production Materials: Developer interviews, production videos, and technical breakdowns related to *Wukong* were reviewed to understand how VR tools were used in actual animation processes.
- Audience Feedback: Comments and reviews from VR film forums and interactive game platforms were analyzed to explore how viewers experience and engage with immersive content. This directly supports the objective of understanding how VR transforms audience involvement.

These sources were chosen to balance perspectives from creators and viewers, giving a fuller picture of how VR impacts both production and storytelling. The triangulation of data sources enhances the credibility of findings and ensures that interpretations are grounded in multiple forms of evidence.

3.3 Data Analysis

The collected material was analyzed using content analysis to identify recurring themes, such as workflow improvements, creative techniques, and immersive experiences. This method is flexible and well-suited for qualitative data, allowing for interpreting interviews, documents, and audience responses while staying focused on the research questions. Content analysis is particularly suitable in this context because it supports the systematic classification of patterns across diverse qualitative materials without reducing the richness of the data.

4.0 Findings

The results of this research underline the revolutionary effects of VR technology on the production of animated films. Its uses span from early-stage planning, character modelling, and animation production to audience engagement. These findings directly address the research objectives: (1) to analyze how VR is applied in various stages of animation production, and (2) to examine how it transforms audience engagement in animated films.

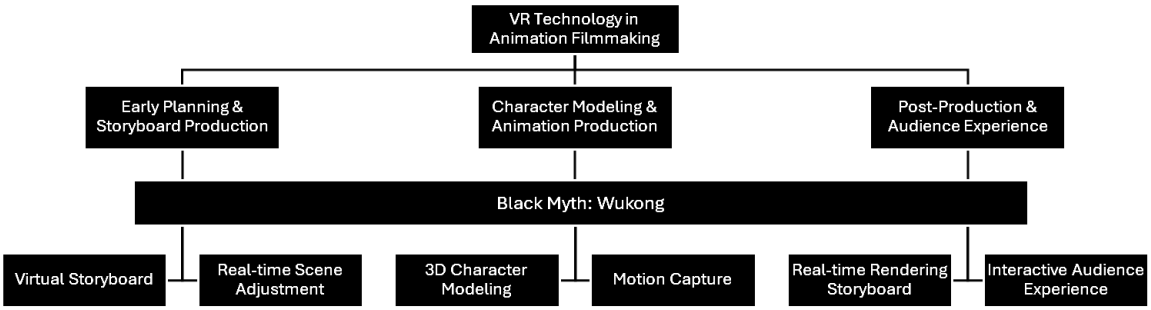

Fig. 1: Diagram of VR Technology Applications in Animation Filmmaking
(Source: Self-created.)

The integration of VR technology in animated filmmaking and its widespread effects are illustrated in Figure 1, where its impact is seen in the primary phases of animatic and storyboard illustration, character model design and animation, and the finalization of production and audience viewing. Through virtual reality, traditional planning techniques can become more sophisticated, such as improving virtual storyboard creation and enabling scene design with more precision. In character modelling, VR provides a 360-degree environment offering precision and realism, further enhanced by motion capture systems that ensure fluid character movements. In transforming post-production and audience experience, VR allows rendering in real-time while transforming viewing into an active and

participatory experience by adding interactive elements. These various applications of VR are aimed at widening the scope of imagination and improving the complete process of animation filmmaking, as seen in *Black Myth: Wukong*.

4.1 Application of VR Technology in Early Planning and Storyboard Production

VR technology irreversibly changes old pre-planning and storyboard methods. These methods usually depend on complex two-dimensional sketches that cannot portray complicated spatial relations and dynamic effects. Using VR, planners can develop and manipulate storyboards in a 3D virtual space, thus enhancing the ideation process.

To put things into perspective with *Black Myth: Wukong*, the production team designed a virtual storyboard environment using VR headsets, allowing them to make live scene previews and adjustments. This was highly beneficial in planning as it allowed teams to improve accuracy and efficiency, and scene design could be immediately altered and tested.

4.2 Application of VR Technology in Character Modeling and Animation Production

Accurate performance and model quality are enhanced with VR in character modelling and animation production. Traditional methods tend to be restrictive as they mainly depend on plan views or static models, making detailed changes problematic. VR gives artists a three-dimensional virtual space, enabling them to view the model from every angle. Combined with motion capture systems in animation production, VR allows for more natural and fluid character movements. While animating, character movements are made more realistic using VR and motion capture systems. As seen in *Black Myth: Wukong*, the team developed hyperrealistic 3D models that were then animated through motion capture and recorded accurate actor movements, resulting in incredibly immersive and realistic visuals (Lyu et al., 2024).

4.3 Application of VR Technology in Post-Production and Audience Experience

In post-production processing, VR enhances functionality by enabling real-time rendering and scene alterations where materials, light effects, and visual details are optimized in real time. This method improves production processes and brings the final output closer to what the creators had in mind.

In terms of experience, the audience is offered the chance to participate in viewing activities that are more engaging and intensely interactive. *Black Myth: Wukong* features VR elements wherein players can join the game and interact with the virtual world. Such designs enable participants—originally just viewers—to partake in further explorations actively, making the experience more immersive and rewarding (He & Sun, 2024).

In conclusion, the research results confirm that VR technologies significantly influence production workflows, creative expression, and audience participation in animated films. This supports both research objectives, showing that VR enhances technical and artistic processes and redefines how audiences experience animated content. It offers filmmakers a new paradigm where storytelling, interaction, and production are more integrated, flexible, and immersive than ever before.

5.0 Discussion

The development of VR technology in the animated film industry has dramatically advanced production techniques and creative opportunities. Its influence spans technical efficiency, artistic expression, and audience interaction. This discussion reflects on these dimensions, analyzes findings in the context of existing literature, and considers broader implications for animation practice and research.

5.1 Impact on the Production Process

VR technology has significantly transformed animation production by providing a real-time, interactive virtual environment. This has addressed many limitations of traditional 2D-based workflows, which are often slow and error-prone. In this study, VR enabled more precise pre-visualization, streamlined collaboration, and enhanced production speed—echoing that immersive environments improve communication and reduce revision cycles in animation teams.

In the case of *Black Myth: Wukong*, the team's ability to make live adjustments and preview scenes in VR mirrors broader industry trends seen in both Western and Asian animation contexts, where studios are increasingly investing in virtual production pipelines. However, unlike in major studio productions, the adaptability and speed shown in *Wukong* reflect a more agile, cost-effective model from which smaller studios in emerging markets (like Southeast Asia or China) could benefit. These findings suggest that VR is not just a tool for big-budget films—it holds real promise for regional studios seeking to scale up their quality and speed without significant resource expansion.

5.2 Influence on Artistic Creation and Performance

VR also brings a new dimension to artistic creation. Enabling real-time editing in immersive environments gives creators more freedom to experiment with visuals, color, and spatial composition. This aligns with VR, blurring the line between creator and tool and encouraging a more intuitive and responsive creative process.

Moreover, VR's capacity for interactive storytelling shifts the artistic structure of animation from linear to participatory. This was especially visible in *Black Myth: Wukong*, where game players are no longer just observers—they become co-creators of their journey. This echoes trends in narrative game design and interactive cinema globally but is still underexplored in mainstream animated filmmaking.

The artistic implications go beyond what is shown in *Wukong*: this model can be adapted for experimental films, digital museums, or educational content where interactivity deepens engagement.

5.3 Influence on the Audience's Experience

Perhaps the most profound shift revealed by this study is how VR redefines audience engagement. As observed in *Black Myth: Wukong* and comparative works like *The Walking Dead: Saints & Sinners* (Serrano et al., 2016), VR turns passive viewers into active participants. This increases emotional and cognitive immersion—key themes in Presence Theory (Slater & Sanchez-Vives, 2016).

Traditional animation tends to lead the viewer; VR, by contrast, invites exploration. This shift is significant, especially for younger, digitally native audiences who prefer interactive experiences over static content. For local and regional filmmakers, adopting such formats could be a way to compete with larger global productions by offering something more engaging and participatory.

However, access remains a limitation. While VR offers incredible immersion, the need for hardware and technical know-how may limit its reach, especially in developing markets. This challenge highlights the importance of hybrid models—blending traditional viewing with optional interactivity—to make content both advanced and accessible.

5.4 Broader Implications

The implications of this research reach beyond a single case study. First, it suggests that VR can become a standard part of the animation pipeline, especially for teams seeking greater efficiency and flexibility. As VR tools become more affordable, their integration into indie production environments will likely increase.

Second, it points to opportunities for cross-disciplinary innovation. The techniques observed in *Black Myth: Wukong* could be applied to game design, digital storytelling, virtual theatre, and education. For example, interactive history animations or science explainers could use similar methods to boost engagement and comprehension.

Finally, this study contributes to a growing body of work that argues for rethinking narrative theory in animation. VR challenges the traditional roles of filmmaker and audience. It requires creators to think about storytelling, world-building, agency, and interaction—skills that may reshape animation education and professional training in the years ahead.

6.0 Conclusion

The rise of Virtual Reality (VR) technology marks a significant shift in animation filmmaking, changing how production is done and how stories are told and experienced. VR enhances collaboration among production teams, improves efficiency, and offers greater creative freedom. As seen in *Black Myth: Wukong*, VR supports early-stage character modeling, scene visualization, real-time post-production adjustments, and interactive audience engagement. Through immersive environments, it transforms the viewer's role from passive observer to active participant, expanding the boundaries of traditional storytelling. These findings support the research objectives and reinforce that VR will continue influencing animation creation and consumption.

This study, however, is not without limitations. It is focused on a single case study, and data is based primarily on available secondary sources, which may not fully represent the diversity of animated productions or regions. To build on this research, future studies could explore multiple case studies across different animation genres and markets, examine the use of VR in smaller local studios, or compare VR-integrated pipelines with traditional production methods. For broader industry adoption, it is recommended that VR training becomes more accessible for independent creators and educators and that collaborations between artists and tech developers continue to improve VR tools and usability. Animation schools could also integrate immersive media into their programs to prepare future creators.

This research contributes to the field by showing how VR enhances both the production process and the audience experience in animated films. Stakeholders such as animation studios, educators, technology developers, and researchers can all benefit from these insights. Studios gain a reference for improving workflows and embracing interactivity; educators can update training to include VR-based practices; developers can refine tools to meet creative needs better; and researchers can explore new questions related to storytelling, engagement, and digital media. Most importantly, audiences benefit from more immersive and emotionally engaging experiences, marking a new era in animated storytelling. Future research could investigate the long-term psychological effects of immersive storytelling on different audience demographics and how cultural narratives are adapted within VR environments. Additionally, studies could analyze the sustainability and cost-efficiency of VR production in comparison to conventional techniques over extended production cycles.

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Paper Contribution to Related Field of Study

This research contributes meaningfully to animated film production by exploring how Virtual Reality (VR) technology enhances various aspects of the animation pipeline—from pre-production planning to post-production and audience interaction. Through the case study of *Black Myth: Wukong*, the paper highlights how VR improves production efficiency, supports creative expression, and introduces new possibilities for interactive storytelling. It demonstrates how virtual storyboards, motion capture, and immersive world-building can be integrated to transform animation's technical and artistic aspects. These insights offer a practical foundation for understanding the growing role of immersive technologies in modern animation practices.

The findings of this study will benefit several stakeholders. Animation studios and production teams can apply the insights to improve workflows and embrace new forms of audience engagement. Educators and academic institutions may use this research to inform curriculum updates and prepare students for the future of digital media. Technology developers can gain a better understanding of how VR is used creatively, leading to more intuitive tools and platforms. Researchers in media, storytelling, and human-computer interaction may also build on this work to further examine immersive narrative formats. Ultimately, audiences stand to gain the most—enjoying more interactive, emotionally engaging, and personalized storytelling experiences made possible through VR.

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