Real-time Stage Modelling and Visual Effects for Live Performances

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Figure 1: A mixed-reality performance featuring a 3D digital actor and live visual effects interacting with a live audience.

ABSTRACT

We present a novel live platform enhancing stage performances with real-time visual effects. Our demo showcases real-time 3D modeling, rendering and blending of assets, and interaction between real and virtual performers. We demonstrate our platform's capabilities with a mixed reality performance featuring virtual and real actors engaged with in-person audiences.

KEYWORDS

live visual effects, real-time performance, mixed reality, televerse

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1 INTRODUCTION

The 3D visual effects (VFX) pipeline has advanced in creating high-fidelity mixed reality content, seamlessly blending virtual elements into live-action films for recorded media, including VFX movies and feature films. To bring mixed reality effects to live performances, it is necessary to transform the traditional VFX pipeline into a real-time platform that effectively addresses key technical challenges. This involves reconstructing a 3D digital twin of large-scale real environments [Chen et al. 2022], such as auditoriums and theaters, comprising both the stage and audience area. Additionally, to seamlessly integrate 3D virtual assets into the 3D digital twin, it is important to ensure consistent lighting and appearance [Rhee et al. 2017] that aligns with the real stage [Young et al. 2022] in real-time. Furthermore, enabling mutual interaction between real and

virtual performers becomes important for attaining synchronized mixed reality performances [Rhee et al. 2022]. In this presentation, we showcase a novel real-time VFX platform that effectively addresses these challenges, while demonstrating a live mixed reality performance engaging with in-person audiences (Figure 1).

2 TECHNICAL CONTRIBUTIONS

Our platform integrates novel solutions to tackle the key technical challenges faced in the development of live VFX for stage performances. Through these novel technical contributions and interfaces, we aim to provide augmented telepresence [Rhee et al. 2020] and synchronized mixed reality experiences. We demonstrate the following contributions:

Contribution-1: Real-time panoramic RGB-D video capturing with multiple cameras on stage. We showcase the real-time capture of large-scale environments by utilizing panoramic depth videos obtained from LiDAR sensors. The captured depth videos are synchronized with 360° RGB videos, allowing us to visualize live panoramic RGB-D videos (Figure 2). To extend the coverage for creating a comprehensive 3D digital twin, we incorporate multiple RGB-D cameras placed in different areas of the auditorium.

Contribution-2: Real-time VFX with live RGB-D videos. We present real-time blending of 3D virtual objects into live panoramic videos, highlighting seamless integration and handling of illumination, occlusion, and collisions between the virtual and real elements.

Contribution-3. Mixed-reality performance featuring virtual and real actors on stage. We showcase a captivating mixed-reality interaction between virtual and real actors, seamlessly blended with live visual effects. Our platform demonstrates how a 3D virtual actor can navigate the physical stage, interact with dynamic changes in the physical environment, engage with the audience in the auditorium, and interact with the real performer.

3 LIVE PERFORMANCE

We present our novel platform on the *Real-time Live!* stage, featuring a live performance with audiences (Figure 1) demonstrating the potential of our platform to enhance stage performances with live visual effects. Our demonstration encompasses three main stages.

Stage-1: Real-time Panoramic RGB-D Videos. We demonstrate the real-time capturing of a large scene (e.g., auditorium), utilizing panoramic RGB-D videos on the stage (Figure 2). We showcase the live capturing process of panoramic depth, depth refinement, 3D point cloud generation, mesh generation, and visualization of live panoramic RGB-D videos. Multiple RGB-D capturing points on the stage operate together in synchronization, approximating a large-scale live environment.

Stage-2: Real-time Blending and Live Visual Effects. We showcase the seamless blending of 3D assets into live-streaming RGB-D 360 videos. We introduce the novel interactive effects achievable through the live-streaming RGB-D 360° videos. This includes interactive occlusion and collision handling between the real and virtual elements, offering seamless integration of the virtual world with the live performance.

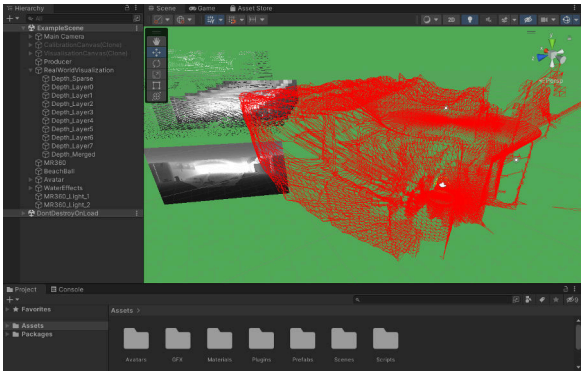

Figure 2: Real-time panoramic RGB-D video capturing.

Stage-3: Virtual Actor Interactivity. In the final stage, we demonstrate the interactivity of virtual actors on the live stage as they interact with physical actors and audiences. The virtual actors navigate and engage with the dynamic real-world environment. We aim to illustrate the seamless integration and interaction between real and virtual performers, bringing a captivating mixed reality experience to the live performance setting.

4 CONCLUSION

Our real-time VFX platform and live performance on the *Real-time Live!* stage demonstrates the potential of merging virtual and real elements in a live setting. Through real-time panoramic RGB-D videos, live blending and visual effects, and virtual actor interactivity, we showcase innovative solutions for synchronized mixed reality performances. This opens up captivating possibilities that bridge the virtual and real worlds. We anticipate further advancements and future applications in live mixed reality performances.

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REFERENCES

Rongsen Chen, Fang-Lue Zhang, Simon Finnie, Andrew Chalmers, and Taehyun Rhee. 2022. Casual 6-DoF: free-viewpoint panorama using a handheld 360 camera. *IEEE Transactions on Visualization and Computer Graphics* (2022).

Taehyun Rhee, Andrew Chalmers, Weng Khuan Hoh, Richard Roberts, Warren Butcher, Simon Finnie, and Rose Barrett. 2022. Teleport to the Augmented Real-World with Live Interactive Effects (IFX). In *SIGGRAPH Asia 2022 Real-Time Live! (SA '22)*. ACM, Article 5, 1 pages.

Taehyun Rhee, Lohit Petikam, Benjamin Allen, and Andrew Chalmers. 2017. Mr360: Mixed reality rendering for 360 panoramic videos. *IEEE transactions on visualization and computer graphics* (2017).

Taehyun Rhee, Stephen Thompson, Daniel Medeiros, Rafael Dos Anjos, and Andrew Chalmers. 2020. Augmented virtual teleportation for high-fidelity telecollaboration. *IEEE transactions on visualization and computer graphics* (2020).

Jacob Young, Stephen Thompson, Holly Downer, Benjamin Allen, Nadia Pantidi, Lukas Stoecklein, and Taehyun Rhee. 2022. TeleFest: Augmented Virtual Teleportation for Live Concerts. *ACM International Conference on Interactive Media Experiences* (2022).