Real VR

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Since the times of the Lumière brothers, the way we watch movies has not fundamentally changed: whether in movie theaters, on mobile devices, or on TV at home, we still experience movies as outside observers, watching the action through a proscenium defined by the size of the screen. Unfortunately, the limited size of the screen causes our peripheral vision to remind us subconsciously that we are only outside observers and not "really there." With the advent of consumer VR headsets, this outside-observer paradigm of visual entertainment has given way to a truly immersive experience. In immersive displays, the action completely encompasses the viewer, drawing us into the action and providing an acute sense of "being there." Unsurprisingly, this paradigm shift has taken hold first in video gaming where content has always been completely computer-generated. Now, *Real VR* lays the foundations for the next step: How to import real-world video recordings into VR headsets? To attain this goal, two ambitious challenges must be tackled in unison. Suitable digital representations must be created from real-world footage that allow real-time rendering from arbitrary vantage points, including stereo vision and egomotion parallax. And the degree of perceptual realism of VR headsets must be enhanced to the point where depictions of real-world scenes appear truly genuine to our visual sense. Finding viable solutions to these challenges in *Real VR* will allow us to experience movies, concerts, or even live sports events with a sense of "being there," which is unattainable with today's existing technologies.

This Special Issue contains six articles, selected through the formal *IEEE Computer Graphics and Applications* review process, which highlight and address some of the interdisciplinary research challenges toward creating complete, perceptual immersion into recorded and/or remote live-action scenes.

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Thatte and Girod present a full end-to-end pipeline to create 6-DoF experiences for anyone interested in implementing VR systems from real captured content. "Real-World Virtual Reality With Head-Motion Parallax" details all necessary steps: from capturing by a stacked circular camera rig and two alternative intermediate representations, to the real-time rendering of real-world scenes including head-motion parallax.

Mobile phones are an affordable alternative to high-end devices; however, their hardware constraints hinder the reconstruction and display of real-world scenery. "High Visual-Quality Scenes in Low-Cost Virtual Reality With Collisions and Irregular Surfaces" addresses these challenges. Selzer, Luján Ganuza, and Castro propose a perceptually validated image-based rendering technique allowing an overall better experience when navigating real-world environments on low-cost devices.

Populating VR environments is crucial for immersion, but to create perceptually plausible animated virtual humans is not trivial. To tackle this difficult task, Paier, Hilsmann, and Eisert present in "Example-Based Facial Animation of Virtual Reality Avatars Using Auto-Regressive Neural Networks" a real-time hybrid approach to automatically generate realistic facial animations from just a series of simple semantic labels.

The freedom that VR gives us to fully explore the environment poses a problem for storytelling in 360° cinematographic content. Traditional visual cues to redirect the users' attention might not be available for the creator; thus, Masia *et al.* study the use of diegetic directional sound cues. "Influence of Directional Sound Cues on Users' Exploration Across 360° Movie Cuts" explores and quantifies the impact of this aural alternative to influence the users' behavior.

Naturally, the applications of *Real VR* span more than just entertainment. "The Potential of 360° Virtual Reality Videos and Real VR for Education—A Literature Review" provides an in-depth analysis of over 60 state-of-the-art articles. Pirker and Dengel highlight the benefits of this technology for the learning process, and emphasize the potential and need for further research on 360° video live content.

Education is also showcased as an application scenario for Zingsheim *et al.*'s work: "Collaborative VR-Based 3-D Labeling of Live-Captured Scenes by Remote Users." They present a real-time remote-access labeling VR/AR system that supports live-capturing of static scenes. Their application allows for a user to scan a 3-D scene and for multiple remotely located users to jointly label it.

We are indebted to Pak Chung Wong and his team for their great help and guidance in organizing and producing our Special Issue. We also wish to express our deep appreciation for all authors' and reviewers' diligent and hard work, which was essential in bringing this issue to fruition. We hope that you, our readers, will enjoy the result of our endeavor and that this collection of articles will stimulate and inspire your own research on Real VR.

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