OmniPhotos: Casual 360° VR Photography with Motion Parallax

Tobias Bertel

tbb28@bath.ac.uk Mingze Yuan

mzy22@bath.ac.uk Reuben Lindroos

ril67@bath.ac.uk

Christian Richardt christian@richardt.name

State-of-the-art approaches to create 360° real-world VR experiences involve time-consuming or expensive capture processes. We introduce OmniPhotos, a novel approach for casually and reliably capturing 360° VR panoramas. Our approach only requires a single sweep of a consumer 360° video camera as input, which takes less than 3 seconds with a rotating selfie stick. It provides 5-DoF real-world VR experiences rendered from a hybrid scene representation consisting of a coarse scene-specific proxy geometry and optical flow between consecutive video frames. We captured 50+ OmniPhotos in six countries across Europe and Asia.

1 Introduction

State-of-the-art 360° VR photography relies on panoramic light fields [3] requiring time-consuming capture and processing of more than a thousand input photos. Hedman and Kopf's Instant 3D Photography approach [2018] reconstructs high-quality textured panoramic meshes from dozens of captured colour+depth images, with full 360° VR photographs requiring more than a minute of capture time. 3D reconstruction also remains fragile and prone to artefacts, e.g. for thin or distant objects in a scene. The MegaParallax approach [1] works on a sparse circular light field which creates high-quality motion parallax using view-dependent flowbased blending. Artefacts are caused by using a trivial proxy¹. We introduce OmniPhotos, which takes advantage of a consumer 360° video camera on a rotating selfie stick: (1) Capture time is reduced to less than 3 seconds, enabling truly casual 360° VR photography. (2) The omnidirectional field of view of 360° cameras unlocks a significantly enlarged viewing area. (3) We improve the visual fidelity of the VR viewing experience by automatically and robustly reconstructing a scene-adaptive proxy geometry.

2 Our Approach

The input to our approach is one 360° video captured by a consumer camera 360° moving on a circular path. This can be achieved quickly (1.7 seconds on average) using a rotating selfie stick, as illustrated in Figure 1. We use an Insta 360° one X camera² to capture 4K 360° video at 50 Hz. We process a raw input 360° video by stitching it with camera stabilisation, and estimate camera poses and a sparse 3D point cloud of the scene using off-the-shelf SLAM software. We also precompute optical flow between pairs of adjacent images, directly on the stitched equirectangular images, which enables high-quality view synthesis at run time [1]. We propose a proxy fitting technique that robustly produces scene-adaptive proxy geometry that clearly outperforms simple planar or cylindrical proxies as used before [1] (see Figure 1). Newly captured OmniPhotos can be processed in about 30–40 minutes on a standard computer ³.

We apply view-dependent flow-based blending using precomputed flow fields in combination with our deformed mesh as proxy to render high-quality VR experiences. To render into a HMD we use OpenVR, which supports SteamVR, Oculus and Windows MR using the same code base. For more details, see our technical paper published at SIGGRAPH Asia 2020.

3 Experience

We show one OmniPhoto in Figure 1 and many more in our supplemental video, which gives a better impression of the visual experience. More Om-

Department of Computer Science, University of Bath, Project webpage







360° optical flow Proxy (inside, from ab Image-based scene representation



Comparisons of 360° VR photography methods

Figure 1: OmniPhotos are 360° VR photographs with motion parallax that can be casually captured in a single 360° video sweep. Capturing takes 3–10 seconds and, once processed into an image-based scene representation, OmniPhotos can be viewed freely in consumer VR headsets.

niPhotos can be found in our online gallery. We invite virtual attendees to experience our best and most immersive 360° VR photographs first hand using a downloadable demo (Windows only) that supports a wide variety of VR headsets as well as a normal windowed mode. Enjoy the photos and hit us with your question during the live Q/A sessions!

- T. Bertel, N. D. F. Campbell, and C. Richardt. MegaParallax: Casual 360° panoramas with motion parallax. *TVCG*, 2019.
- [2] P. Hedman and J. Kopf. Instant 3D photography. SIGGRAPH, 2018.
- [3] R. S. Overbeck, D. Erickson, D. Evangelakos, M. Pharr, and P. Debevec. A system for acquiring, compressing, and rendering panoramic light field stills for virtual reality. *SIGGRAPH Asia*, 2018.

 $^{^1}$ Vertical distortion caused by using a trivial proxy geometry, e.g. a plane or cylinder 2 https://www.insta360.com/product/insta360-onex

³i7 3 GHz 8-core CPU, 16 GB RAM, NVIDIA GeForce RTX 2060