Trios: Stylistic Rendering of 3D Photos

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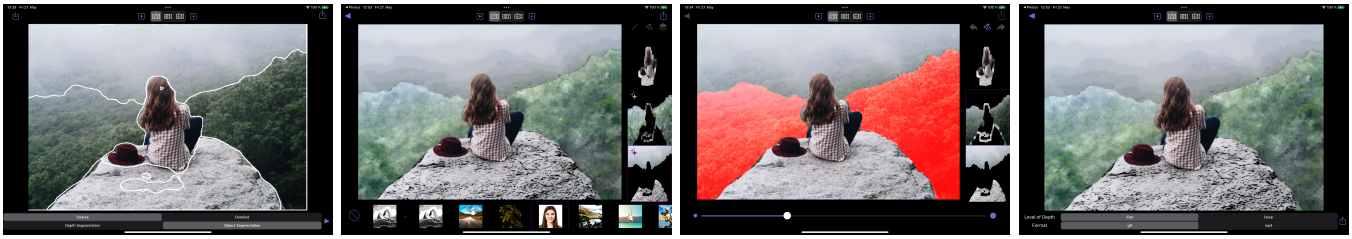

(a) Segmentation Screen (b) Stylization Screen (c) Touch-Up Screen (d) Export Screen

Figure 1: Overview of the main user interface screens provided by our prototypical application.

ABSTRACT

3D photography has emerged as a medium that provides an immersive dimension to 2D photos. We present *Trios*, an interactive mobile app that combines the vividness of image-based artistic rendering with 3D photos by implementing an end-to-end pipeline for their generation and stylization. *Trios* uses Apple's accelerated image-processing APIs and dedicated Neural Engine for depth-generation and learning-based artistic rendering. The pipeline runs at interactive frame rates and outputs a compact video, which can easily be shared. Thus, it serves as a unique interactive tool for digital artists interested in creating immersive artistic content.

SIGGRAPH '22 Appy Hour, August 07-11, 2022, Vancouver, BC, Canada

ACM ISBN 978-1-4503-9365-2/22/08.
https://doi.org/10.1145/3532723.3535467

CCS CONCEPTS

• **Computing methodologies** → **Image-based rendering**; **Image processing**; **Non-photorealistic rendering**; • **Human-centered computing** → **Ubiquitous and mobile computing systems and tools**.

KEYWORDS

3D photos, image stylization, mobile devices

ACM Reference Format:
Ulrike Bath, Sumit Shekhar, Hendrik Tjabben, Amir Semmo, Sebastian Pasewaldt, Jürgen Döllner, and Matthias Trapp. 2022. Trios: Stylistic Rendering of 3D Photos. In *Special Interest Group on Computer Graphics and Interactive Techniques Conference Appy Hour (SIGGRAPH '22 Appy Hour), August 07-11, 2022*. ACM, New York, NY, USA, 2 pages. https://doi.org/10.1145/3532723.3535467

1 MOTIVATION

Due to the progress in mobile graphics, smartphones and tablets nowadays allow for a large range of on-device image-processing.

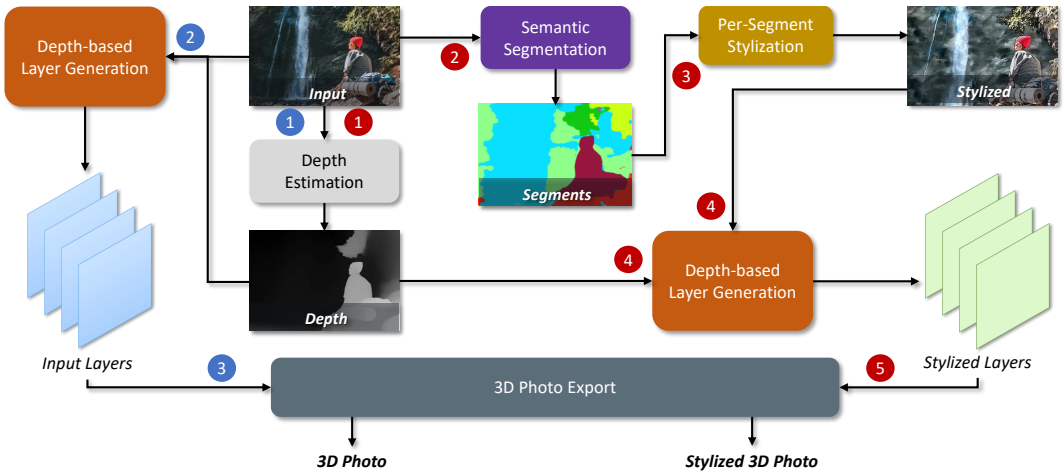

Figure 2: Schematic overview of the processing pipeline implemented in *Trios*; steps 1-3 depict the generation of a *3D Photo* and steps 1-5 the generation of a *Stylized 3D Photo*.

On-device 3D photo generation for visual immersiveness is a compelling example in this regard [Kopf et al. 2020]. Previously, apps for Image-based Artistic Rendering (IB-AR) also exploited the advanced visual computing capabilities of mobile devices [Pasewaldt et al. 2016; Semmo and Pasewaldt 2020]. As compared to traditional IB-AR approaches, 3D photos offer new possibilities with respect to stylization and visualization. In this work, we extend the visual-richness of IB-AR techniques to 3D photos. Thus, we develop a mobile-based framework for generation and stylization of 3D photos given an input RGB-image.

2 BACKGROUND & TECHNICAL OVERVIEW

Hedman *et al.* proposed the first approach for 3D photo acquisition [2017]. Since then, significant progress advanced to method being capable of running fully on a high-end smartphone [Hedman and Kopf 2018; Kopf et al. 2020; Shih et al. 2020]. However, most of the existing methods do not consider user interactivity during creation and editing of 3D photos. Our framework adopts the following approach for generation and interactive stylization of 3D photos on high-end mobile devices (Fig. 2).

Depth Estimation We employ the mobile-version of MiDaS, a depth estimation technique by Ranftl *et al.* [2022], to generate a depth map for the given input image.

Layer Generation The depth map is used to decompose the RGB image into *input layers* at different depth levels and represent these as a Layered Depth Image (LDI) [Shade et al. 1998], stored in a 2D texture array for GPU-based processing.

Semantic Segmentation The input image is separated into semantic segments for the purpose of stylization.

Per-Segment Stylization Following the above, we employ a variety of classical and learning-based IB-AR techniques for stylizing individual segments.

Stylized Layers Similar to *input layers*, the depth map is used to decompose the stylized image into *stylized layers* and is represented as an LDI.

3D Photo Export The LDI representation of *input* or *stylized* layers can be traversed in different ways using a virtual camera to obtain a 3D Photo as a video or GIF.

Our prototypical framework is based on iOS and iPadOS using Swift, UIKit, CoreImage, CoreML, and Metal Application Programming Interfaces (APIs). The principal methodology is not limited to Apple devices and can be extended for other environments as well.

ACKNOWLEDGMENTS

This work was partially funded by the BMBF (01IS18092-"mdViPro" and 01IS19006-"KI-LAB-ITSE") and the Research School on "Service-Oriented Systems Engineering" of the Hasso Plattner Institute.

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