An Extended-Depth-Range Volumetric Near-Eye Display

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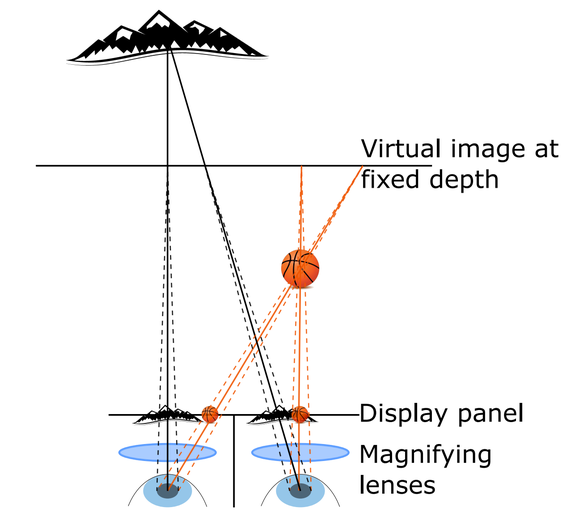
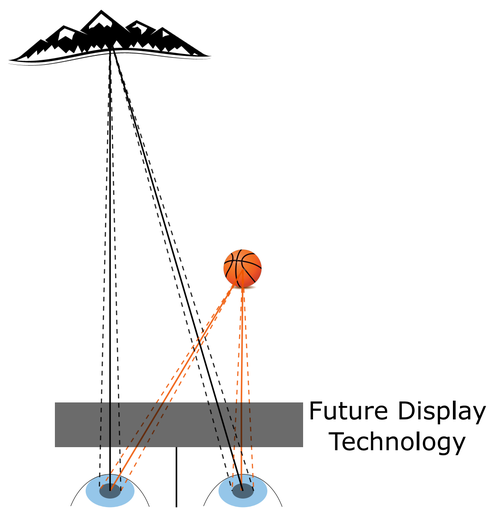
Introduction

Current generation VR and AR displays present virtual images at a fixed depth. This allows for natural stereopsis but does not allow natural accommodation.

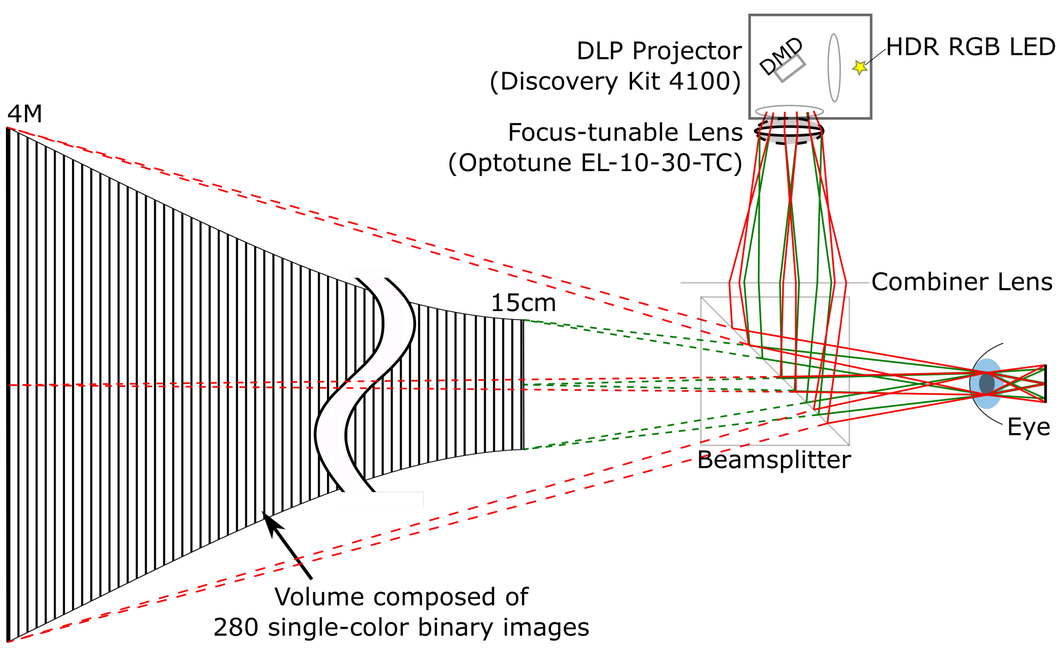


Conventional VR/AR Displays

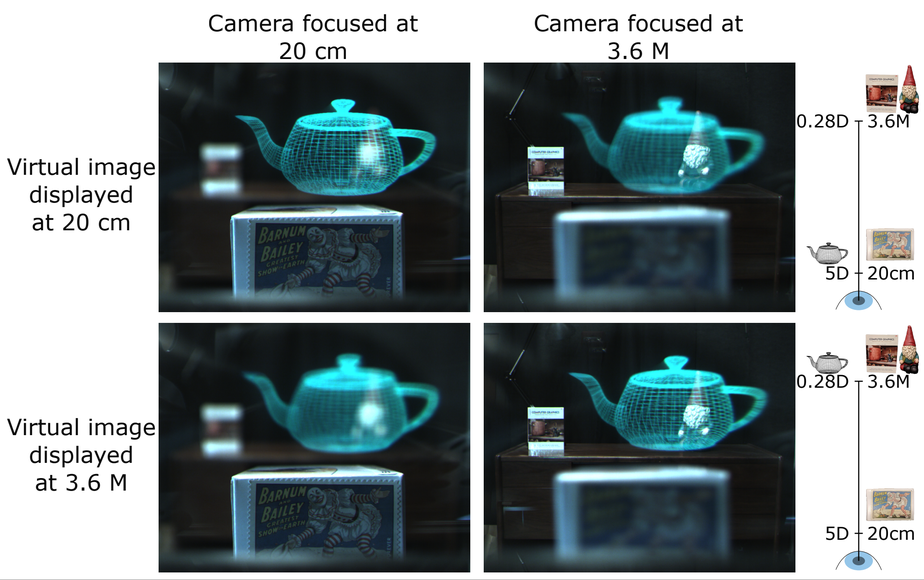


Ideal VR/AR Displays

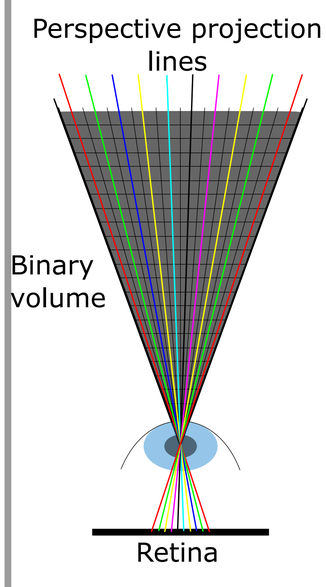
System Overview



A high-speed DMD projector is synchronized to a sinusoidally oscillating focus-tunable lens and an HDR RGB LED that changes illumination color and intensity per-binary-frame. Example binary images as seen through the display:



Rendering Pipeline

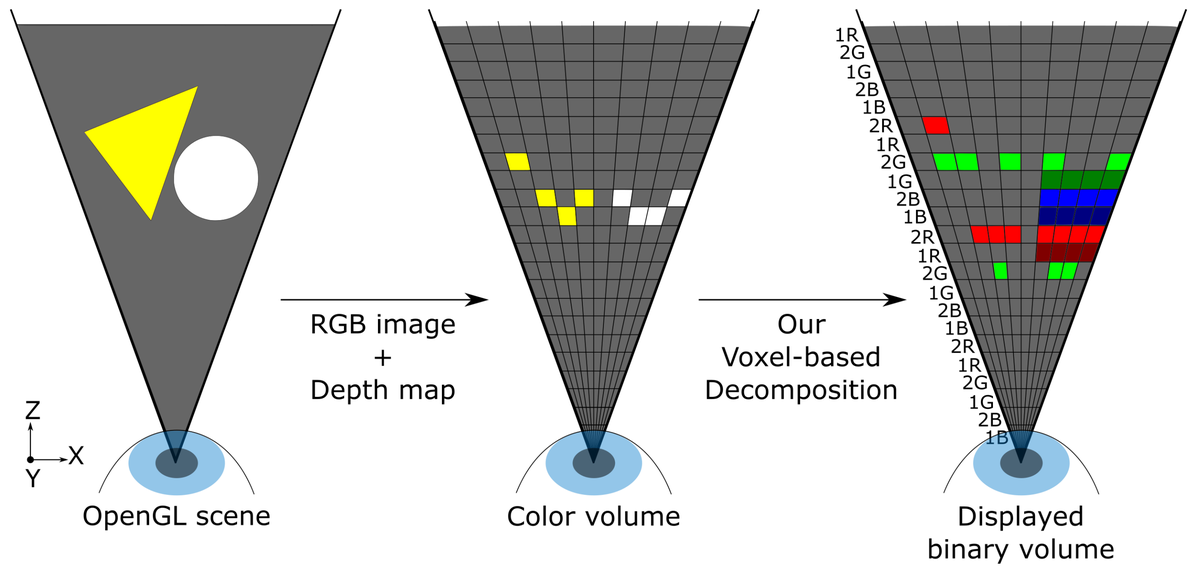


How to decompose a 3D scene to binary images?

Main ideas are:

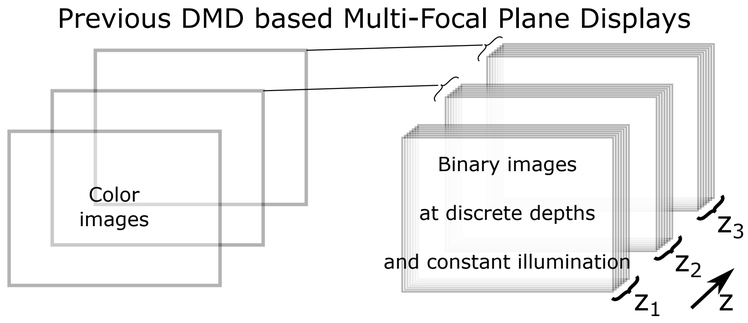
1. Each color voxel can be decomposed into multiple binary voxels that are distributed along its perspective projection line.
2. The decomposed binary voxels need to be sufficiently close to the color voxel.
3. The decomposed binary voxels can be arranged in an arbitrary order.

Image shows our current fixed-pipeline decomposition algorithm:

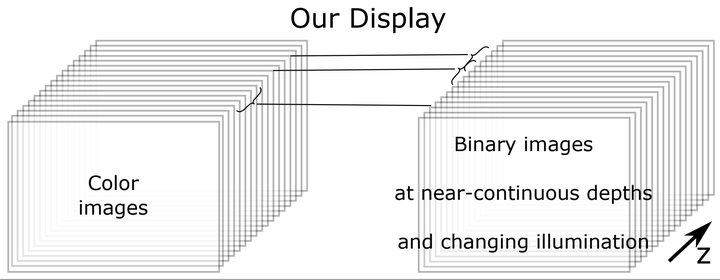


Previous approaches for similar hardware programmed the lens to step through discrete focal lengths, used constant intensity illumination, and an image-based decomposition algorithm. Our implementation uses continuously changing lens focal length, per-binary frame illumination control, and a new decomposition algorithm.

Previous DMD based Multi-Focal Plane Displays



Our Display



Results

We demonstrate high depth range, high depth resolution, native spatial resolution, full-color imagery, at interactive frame-rates simultaneously. Images below show the view through the near-eye display. Only the camera's focus setting is changed to bring different parts of the scene into focus.

Rathinavel, Kishore, Hanpeng Wang, Alex Blate, and Henry Fuchs. "An Extended Depth-at-Field Volumetric Near-Eye Augmented Reality Display." ISMAR & IEEE TVCG 2018
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