Real-time Content Adaptive Depth Retargeting for Light Field Displays

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Objectives

1. We address the problem of depth retargeting for light field displays to enhance the quality of visual perception.
2. We present a system that concurrently analyzes the scene depth structure and produces a non-linear mapping from scene to display.
3. We automatically detect the salient regions in a scene and preserve their 3D appearance after retargeting.

Introduction

HoloVizio light field displays use a holographic diffuser that allows directional light transmission with minimum aliasing and can provide high angular frequency. However, due to the discrete nature of the system aliasing is inevitable, especially when displaying objects at depths outside the depth of field of the display. In the current work, we propose an approach to automatically modify the 3D scene to suit the depth characteristics of a light field display.

Proposed method

We assume a mesh based representation of the scene. By iterating through all the mesh nodes in a scene, we compute the depth space occupied by each mesh node in real world. To ensure smooth transition between successive depth steps in display space, we quantize the scene depth space into various depth zones. We then estimate a depth histogram to find out the salience inside each quantized depth zone. The number of quantization steps is carefully chosen to reduce perspective distortions at object boundaries. Using the saliency information, we formulate and solve a convex optimization problem to estimate the quantized depth values in display coordinates.

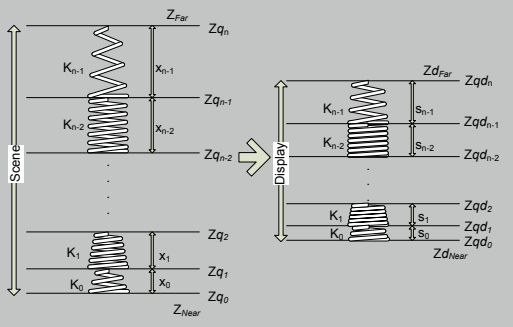

Figure 1: Computation of content aware depth retargeting function : Scene depth space is quantized into n clutters and saliency is computed inside each. Clutter sizes in the retargeted display space is computed by solving a convex optimization. Z_{qi} and Z_{qdi} denote i^{th} quantized depth level in scene and display spaces respectively.

Our aim is to minimize: $\sum_{i=0}^{qn-1} \frac{1}{2} K_i (S_i - X_i)^2$
subject to: $\sum_{i=0}^{qn-1} S_i = D_d \; S_i > {D_{cs}}^{min}, i = 0, 1, ..., n-1$
Where, X_i and K_i are the length and stiffness of i^{th} clutter spring, D_d is the total depth of field of the display and ${D_{cs}}^{min}$ are the minimum and allowable sizes of the resulting display space clutters. In order to ensure that the content on the screen plane stay after retargeting, we impose a last boundary condition mapping the two planes in original and retargeted space. For each point in the scene, we compute a new point in the display $z_{display} = f(z_{scene})$ using piecewise linear interpolation.

Results

Figure 2: Retargeting results recorded after displaying on a light field display. Top row: two views of original light field content. Middle row: corresponding depth retargeted views. Bottom row: close-ups of retargeting results.

Conclusions and future work

- Our main contribution from the current work is on-the-fly content aware depth retargeting in synthetic environment for light field displays.
- Results show that our method can be used to produce visually pleasing interactive light field content.
- In future work, we plan to extend this concept to retarget the light field rendered from image-based content given as multiview images.

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