Highlights

- **Depth Estimation**: we implemented Adelson’s method for depth estimation from light fields [1].
- **Refocusing**: we also implemented Ng’s Fourier Slice Photography Theorem for refocused images from light fields [2].
- **Analysis**: we report quantitative and qualitative analysis for our reproduction results.

Motivation

- In homework 5, we implemented basic depth estimation and refocusing algorithms.
- In this project, we are interested in exploring more advanced algorithms that might achieve better results.

Dataset

- **Heidelberg 4D Light Field Benchmark**: 9x9x512x512x3 synthetic light fields with ground truth disparity map [3].
- **Stanford Light Field Archive**: 16x16x1024x1024x3 real-world light fields acquired by Stanford Computer Graphics Lab [4].

References


Depth Estimation

\[
\text{disparity} = \frac{\sum_P (I_x I_v + I_y I_v)}{\sum_P (I_x^2 + I_y^2)}
\]

\[
\text{confidence} = \sum_P (I_x^2 + I_y^2)
\]

\(I\): intensity, \(I_x, I_y\): spatial derivative, \(I_v\): viewpoint derivative

Qualitative Results

![Qualitative Results Image]

Figure 2: Example qualitative results.

Quantitative Results

<table>
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<tr>
<th>scene</th>
<th>town</th>
<th>greek</th>
<th>platonic</th>
<th>dishes</th>
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<td>10.72</td>
<td>8.827</td>
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</table>

Table 1: Example evaluation with MSE and PSNR.

Fourier Slice Photography

- **Implementation pipeline and time complexity [2]**
  
- **Fourier Slice Photography Theorem [2]**
  \[ P_{\alpha} \equiv \mathcal{F}^{-2} \circ \psi_{\alpha} \circ \mathcal{F} \]

Analysis

- **Refocus with different \(\alpha = F'/F\)**

Figure 3: Focus on different depths by changing \(\alpha\).

Figure 4: top:16x16; bottom:8x8

Figure 5: top:2x; bottom:1x

- **Impacts of light field size**: in figure 4, larger light field size will achieve much better refocusing effect, especially when \(\alpha \neq 1\).
- **Impacts of padding**: as shown in figure 5, adding more padding when pre-computing could achieve slightly better performance.