Computer Vision: from Recognition to Geometry

HW4

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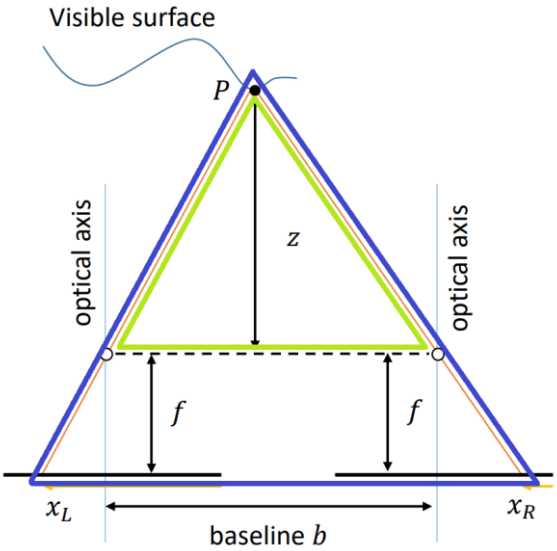
Part 1 – Depth from Disparity

Let $d = x_L - x_R$, and prove that $d = \frac{fb}{z}$.

We can obtain the following equation according to the two similar triangles highlighted in green and blue, respectively.



$$\frac{z}{z+f} = \frac{b}{b+(x_L - x_R)} = \frac{b}{b+d}$$

$\rightarrow \quad z(b+d) = (z+f)b$

$\rightarrow \quad zb + zd = zb + fb$

$\rightarrow \quad zd = fb$

$\rightarrow \quad d = \frac{f \cdot b}{z}$

Part 2 – Disparity Estimation

[Algorithm of the Standard 4-step Pipeline]

- Cost Computation

  There are several ways to obtain the matching costs, and I chose to implement them by shifting the original images with a range of values of disparities, and calculating the truncated mean absolute difference between them. After the cost maps with different disparity values were computed, I padded them back to the size of the original input images.

- Cost Aggregation

  I used a square box filter to perform convolution on the cost map obtained from the last step, and the new costs of each pixel was computed by averaging the cost values of the nearby pixels. Rather than the adaptive crossed-based cost aggregation method, the box filter is relatively time-saving, and my program can be executed within just several seconds.

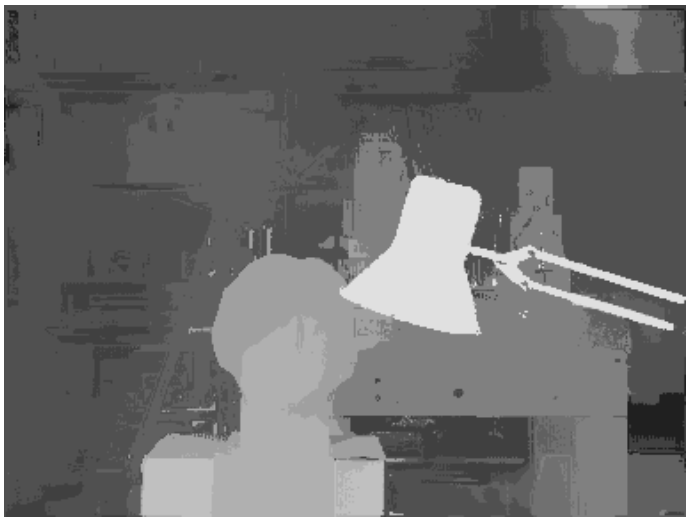
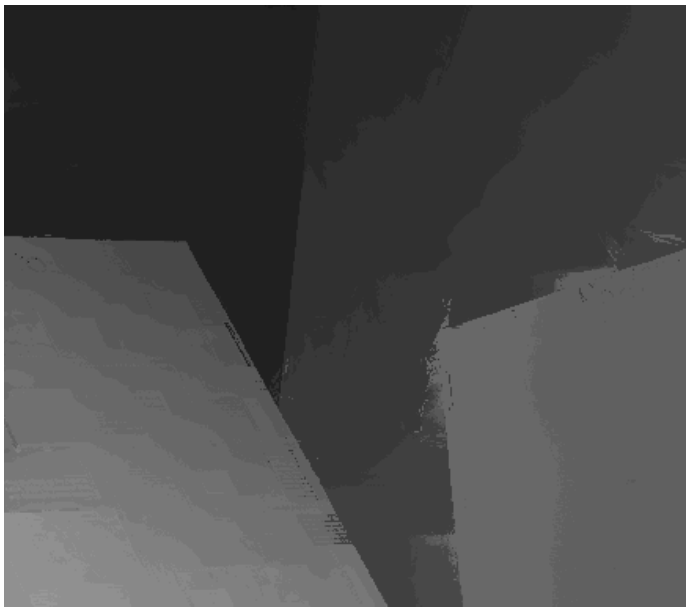
- Disparity Optimization

  The disparity map is generated by simply finding the minimal cost of each pixel from the aggregated cost map.

- Disparity Refinement

  I refined the disparity maps with the hole-filling and the weighted median filtering techniques. During the hole-filling process, I filled the most frequent value inside the given region to the holes in the disparity map. However, this step might not guarantee the coherency between scan lines.

[Output Disparity Maps & Bad Pixel Ratios]

Data	Disparity Map	Bad Pixel Ratio
Tsukuba		4.23 %
Venus		1.15 %

Teddy		15.00 %
Cones		7.86 %

[Reference]

- Ma *et al.* Constant time weighted median filtering for stereo matching and beyond.
- Rhemann *et al.* Fast cost-volume filtering for visual correspondence and beyond.
- Zhang *et al.* Cross-based local stereo matching using orthogonal integral images.