3DMM Final Project

Stereo Matching Performance Optimization in OpenCL

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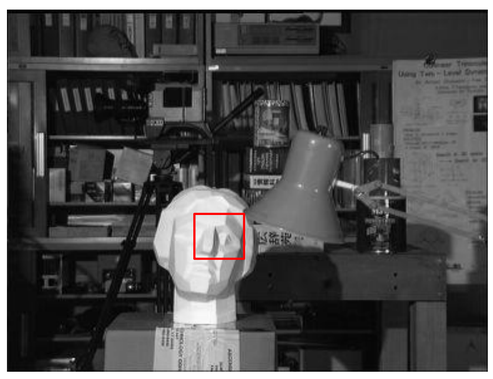
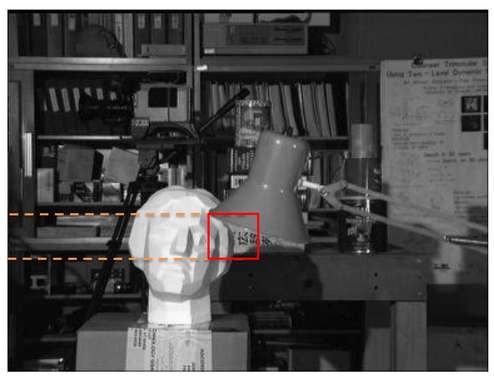
1. What is stereo matching?

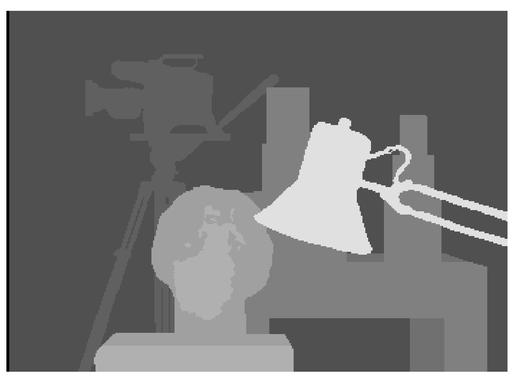
For a point in image 1, where is the corresponding point in image 2?



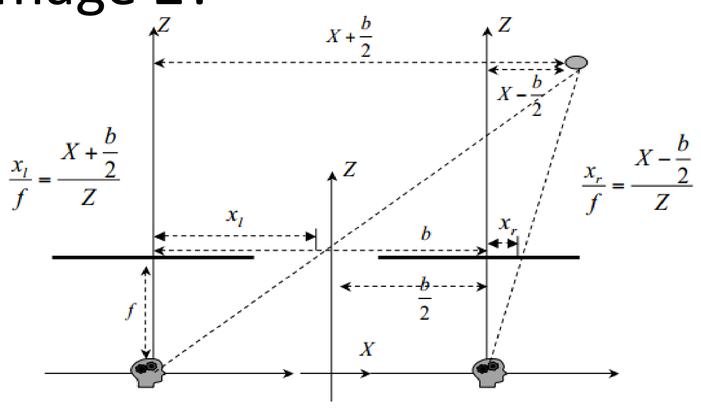
Left image



Right image



Disparity map



Disparity and depth

$$\frac{x_l - x_r}{f} = \frac{b}{Z}$$

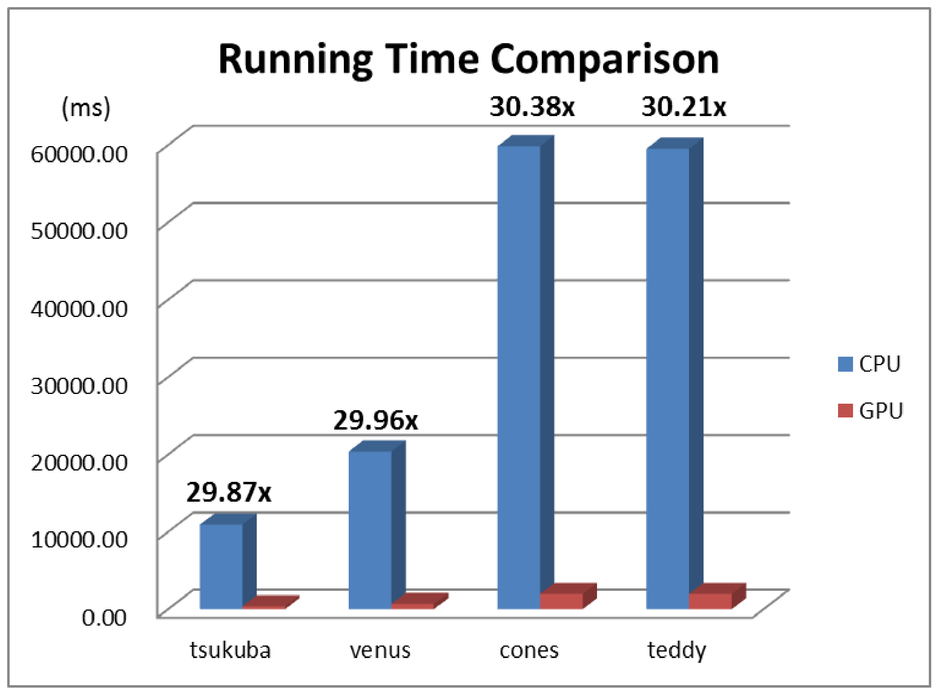
2. Local stereo matching algorithm

2.1 Adaptive support weight method:

$$w(p,q) = \exp\left(-\left(\frac{\Delta c_{pq}}{\gamma_c} + \frac{\Delta g_{pq}}{\gamma_p}\right)\right) \qquad E(p,\bar{p}_d) = \frac{\sum_{q\in N_p, \bar{q}_d \in N_{\bar{p}_d}} w(p,q)w(\bar{p}_d,\bar{q}_d)e(q,\bar{q}_d)}{\sum_{q\in N_p, \bar{q}_d \in N_{\bar{p}_d}} w(p,q)w(\bar{p}_d,\bar{q}_d)}$$

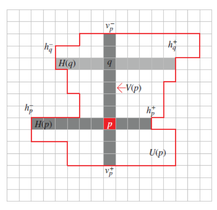
Data set	Size	Disparities	Operation	CPU time(ms)	GPU time(ms)	Speedup ratio
tsukuba	354x288	15	Color conversion	72.51	3.67	**19.74**
			Stereo Matching	10856.90	362.21	**29.97**
			Total	10929.41	365.89	**29.87**
venus	434x383	19	Color conversion	102.45	4.35	**23.57**
			Stereo Matching	20288.20	676.34	**30.00**
			Total	20390.65	680.68	**29.96**
cones	450x375	59	Color conversion	110.46	4.36	**25.32**
			Stereo Matching	59761.80	1966.17	**30.40**
			Total	59872.26	1970.53	**30.38**
teddy	450x375	59	Color conversion	100.34	4.38	**22.90**
			Stereo Matching	59436.90	1966.65	**30.22**
			Total	59537.24	1971.03	**30.21**

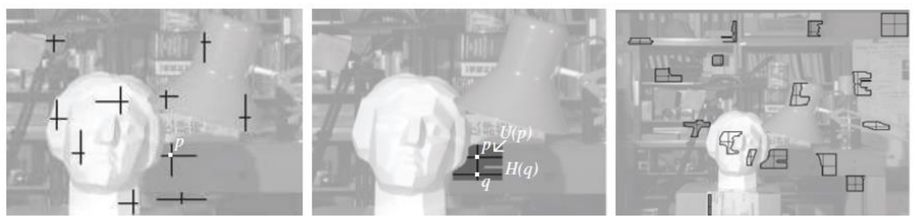
CPU: Intel CORE i7 2630QM　　GPU: NVIDIA GT 540M



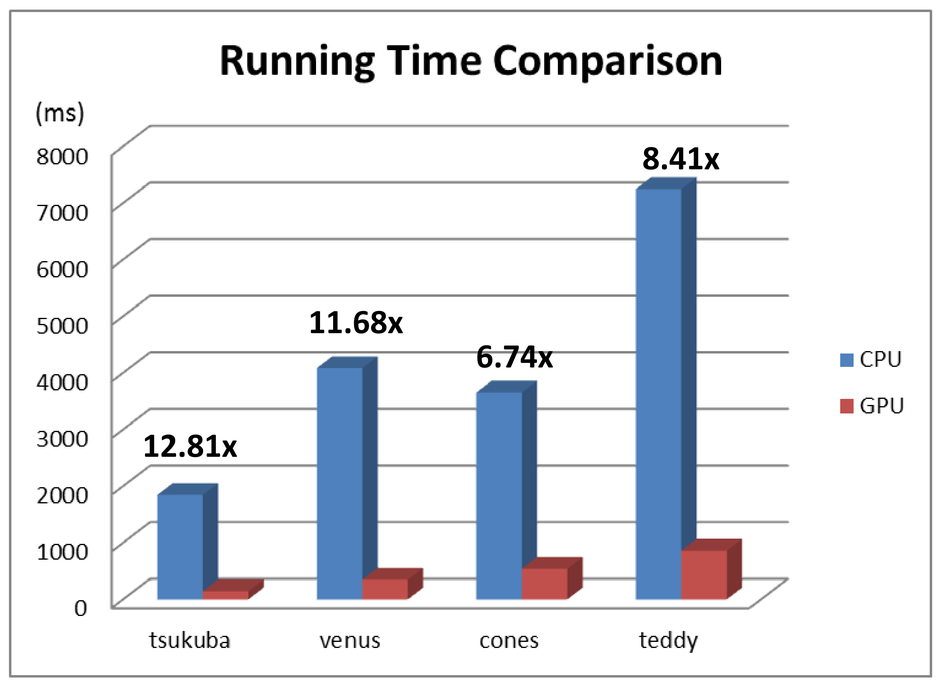
2.2 Cross-based method:

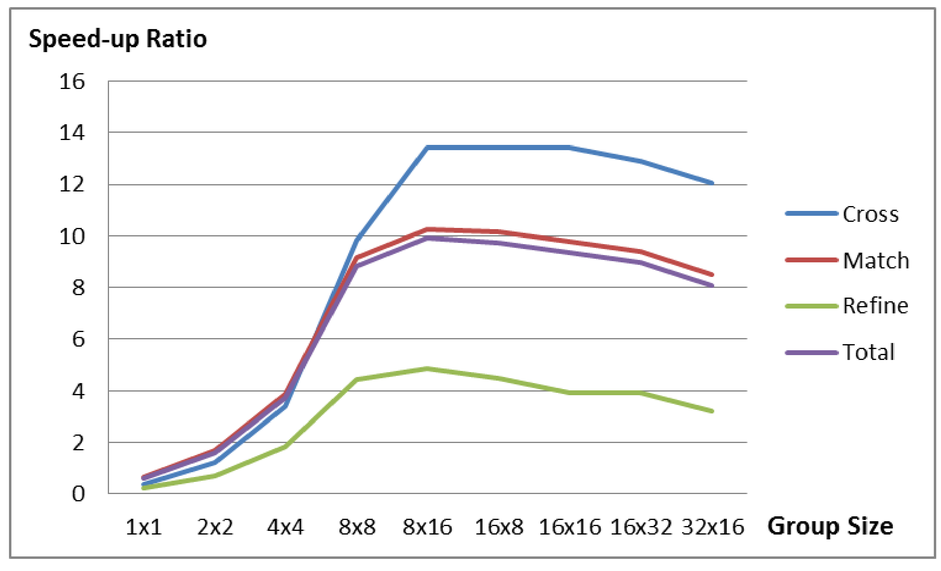
$$\overline{E}_d(p) = \frac{1}{\|U_d(p)\|} E_d(p) = \frac{1}{\|U_d(p)\|} \sum_{s \in U_d(p)} e_d(s)$$





Data set	Size	Disparities	Operation	CPU time(ms)	GPU time(ms)	Speedup ratio
tsukuba	354x288	15	Cross Construction	55.90724	3.864253	**14.4678**
			Stereo Matching	1699.217	126.2564	**13.45846**
			Refinement	88.5829	13.73011	**6.451727**
			Total	1843.707	143.8507	**12.81681**
venus	434x383	19	Cross Construction	90.45587	6.000697	**15.07423**
			Stereo Matching	3840.325	316.73	**12.12492**
			Refinement	153.7537	26.78129	**5.741086**
			Total	4084.535	349.512	**11.68639**
cones	450x375	59	Cross Construction	61.5833	5.406342	**11.39094**
			Stereo Matching	3511.401	510.8408	**6.873768**
			Refinement	80.91072	25.18789	**3.212287**
			Total	3653.895	541.435	**6.748538**
teddy	450x375	59	Cross Construction	75.64388	5.934521	**12.74642**
			Stereo Matching	7041.813	822.6964	**8.55943**
			Refinement	129.2049	32.60316	**3.962956**
			Total	7246.661	861.2341	**8.414276**





3. Performance optimization

- Sometimes it's better to recompute than to cache
- Coalescing memory operations
- Optimize work group size