CUDA HW3

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Problem 1

Lattice size	error	total iterations	Processing time for CPU (ms)	CPU Glops
(32,32)	0.000e0	2606	9.686016	1.695000
(64,64)	5.820e-11	9745	152.521851	1.719219
(128,128)	0.000e0	35073	2273.354004	1.714530
(256,256)	5.821e-11	124611	32721.958984	1.719818
(512,512)	0.000e0	423553	467132.812500	1.650843

Table 1.1: The result of CPU with different lattice size.

Lattice size	Block size	total iterations (GPU)	Processing time for GPU	GPU Gflops	Total time for GPU
32	4	2606	44.078400	0.372468	44.894913
32	8	2606	43.326817	0.378929	44.145794
32	16	2606	44.782242	0.366614	45.612930
32	32	2606	62.370590	0.263230	63.173088
64	4	9745	240.620163	1.089761	241.455811
64	8	9745	234.565979	1.117888	235.392792
64	16	9745	235.896164	1.111584	236.721725
64	32	9746	239.271805	1.096015	240.112030
128	**4**	35073	966.957947	4.030923	**967.864441**
128	**8**	35073	804.380798	4.845631	**805.273438**
128	**16**	35073	791.038269	4.927363	**791.918762**
128	**32**	35073	792.358948	4.919150	**793.185791**
256	**4**	124611	5757.869629	9.773723	**5759.052246**
256	**8**	124611	3545.399170	15.872916	**3546.588623**
256	**16**	124611	3274.562500	17.185753	**3275.761963**
256	**32**	124611	4093.542480	13.747463	**4094.747070**
512	**4**	423553	61116.113281	12.617997	**61118.785156**
512	**8**	423553	28293.888672	27.255460	**28296.533203**
512	**16**	423553	24367.263672	31.647499	**24369.925781**
512	**32**	423553	26425.638672	29.182377	**26428.294922**

Table 1.2: The result for GPU using different block sizes.

Lattice size	Block size	total iterations (GPU)	Processing time for GPU	GPU Gflops	Total time for GPU
32	4	2606	59.554878	0.275675	60.406525
32	8	2606	59.648514	0.275242	60.504417
32	16	2606	55.044289	0.298265	55.894882
32	32	2606	77.300735	0.212389	78.138275
64	4	9745	253.233337	1.035482	254.029236
64	8	9745	200.450302	1.308147	201.237183
64	16	9745	259.072296	1.012144	259.858429
64	32	9745	261.221191	1.003818	261.994720
128	4	35073	1171.060547	3.328378	1171.995117
128	8	35073	987.656738	3.946445	988.588440
128	16	35073	1036.819214	3.759318	1037.734741
128	32	35073	1041.529541	3.742316	1042.465820
256	4	124611	6673.728516	8.432441	6675.068848
256	8	124611	4282.142090	13.141979	4283.412598
256	16	124611	3846.298340	14.631164	3847.516602
256	**32**	124611	3887.917480	14.474542	**3889.037109**
512	**4**	423553	52999.976562	14.550251	**53002.449219**
512	**8**	423553	27398.996094	28.145664	**27401.539062**
512	**16**	423553	24285.384766	31.754199	**24288.074219**
512	**32**	423553	26002.582031	29.657168	**26005.062500**

Table 1.3: The result for GPU using different block sizes with texture.

Discussion 1

Compared **Table 1.1** and **Table 1.2**, we could find the total time usage for GPU is shorter when the lattice size become bigger. Besides, the total time varies using different block size. So, we need to tune a suitable block size for optimized performance. *(The bold numbers in **Table 1.2** have better performance than using CPU.)*

Table 1.3 is using texture for GPU computation, which is not so efficient at small lattice size and small block size. When the lattice becomes bigger, the speed up for texture becomes faster. *(The bold numbers in **Table 1.3** have better performance than without using texture feature.)*

Problem 2

Lattice size	error	total iterations	Processing time for CPU	CPU Gflops
512	2.119e01	1000000	1059864.875000	1.717860

Table 2.1: The result for CPU calculating the 512*512 square lattice.

Lattice size	Block size	total iterations (GPU)	Processing time for GPU	GPU Gflops	Total time for GPU
512	256	1000000	71648.546875	25.411541	71651.195312
512	128	1000000	66887.390625	27.220377	66890.054688
512	64	1000000	57154.343750	31.855846	57156.832031
512	32	1000000	58912.546875	30.905131	58914.957031
512	16	1000000	68412.476562	26.613567	68415.117188
512	8	1000000	63113.714844	28.847930	63116.355469
512	2	1000000	56936.132812	31.977936	56938.574219

Table 2.2: The result for GPU calculating.

Lattice size	Block size	total iterations (GPU)	Processing time for GPU	GPU Gflops	Total time for GPU
512	256	1000000	64537.093750	28.211683	64539.769531
512	128	1000000	64321.937500	28.306050	64324.628906
512	64	1000000	64382.675781	28.279347	64385.316406
512	32	1000000	64356.964844	28.290644	64359.652344
512	16	1000000	63806.328125	28.534787	63808.972656
512	8	1000000	60657.066406	30.016288	60659.511719
512	2	1000000	64301.441406	28.315073	64304.097656

Table 2.3: The result for GPU calculating with texture.

Discussion 2

Checking **Table 2.1**, **Table 2.2** and **Table 2.3**, the lattice size may be too big (512*512), so that it reached the max iterations. I have tried to increase the value of max iterations to "10,000,000". Unfortunately, it didn't help. It still reached the new max iterations. Besides, the initial and the final matrixes are too big and costing too much time, I stop increasing max iterations.

Problem 3

Lattice size	error	total iterations	Processing time for CPU (ms)	CPU Glops
(32,32,32)	0.000e0	2946	530.560364	1.349287
(64,64,64)	5.378e-11	10899	18712.992188	1.249283
(128,128,128)	5.821e-11	41098	627396.875000	1.179322

Table 3.1: The result for CPU calculating the cubic lattice.

Lattice size	Block size	total iterations (GPU)	Processing time for GPU	GPU Gflops	Total time for GPU
32	2	2946	159.637985	4.484384	160.626434
32	**4**	2946	79.356125	9.021081	**80.336983**
32	**8**	2946	73.530205	9.735836	**74.529053**
64	**2**	10899	3063.366699	7.631418	**3065.963867**
64	**4**	10899	885.407043	26.403485	**888.010193**
64	**8**	10899	757.401001	30.865858	**759.966492**
128	**2**	41098	79631.039062	9.291642	**79640.671875**
128	**4**	41098	20237.408203	36.561158	**20247.449219**
128	**8**	41098	15026.566406	49.239664	**15035.583008**

Table 3.2: The result for GPU calculating.

Lattice size	Block size	total iterations (GPU)	Processing time for GPU	GPU Gflops	Total time for GPU
32	**2**	2946	150.707397	4.750119	**151.723434**
32	4	2946	92.755135	7.717934	93.759651
32	8	2956	82.101379	8.749037	83.034470
64	**2**	10899	2491.556152	9.382824	**2493.969482**
64	**4**	10899	735.661072	31.777992	**738.061707**
64	**8**	10899	736.864197	31.726106	**739.498413**
128	**2**	41098	69535.21094	10.640696	**69544.97656**
128	**4**	41098	16047.71680	46.106439	**16057.8457**
128	**8**	41098	13689.07227	54.050637	**13699.35254**

Table 3.3: The result for GPU calculating with texture.

Discussion 3

Similar situation with Problem 1, it is faster using GPU than CPU. Also, using texture feature for GPU is faster than without it when the lattice size becomes bigger.