

Теория параллелизма

Отчет

Задание 8

CUB

Выполнил:

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Компилятор: pgc++

Профилировщик: Nsyght Systems

Замер времени: C++ chrono lib

Результат для матрицы 10x10

Final grid:

```
10      11.1111 12.2222 13.3333 14.4444 15.5556 16.6667 17.7778 18.8889 20
11.1111 12.2359 13.354  14.4625 15.5626 16.6596 17.7597 18.8682 19.9864 21.1111
12.2222 13.3672 14.4956 15.5999 16.684  17.7604 18.8445 19.9488 21.0773 22.2222
13.3333 14.515  15.6613 16.7575 17.8132 18.8535 19.9091 21.0054 22.1517 23.3333
14.4444 15.6983 16.8769 17.9558 18.9577 19.9312 20.9331 22.012  23.1906 24.4444
15.5556 16.9568 18.1921 19.2312 20.1305 20.9806 21.8799 22.919  24.1543 25.5556
16.6667 18.3812 19.7035 20.6464 21.3526 21.9807 22.6869 23.6298 24.9521 26.6667
17.7778 20.1979 21.5944 22.2984 22.6528 22.9028 23.2572 23.9612 25.3576 27.7778
18.8889 23.0383 24.1776 24.3    24.0572 23.7206 23.4778 23.6002 24.7395 28.8889
20      28.8889 27.7778 26.6667 25.5556 24.4444 23.3333 22.2222 21.1111 30
```

Результат для матрицы 13x13

Final grid:

```
10      10.8333 11.6667 12.5    13.3333 14.1667 15      15.8333 16.6667 17.5    18.3333 19.1667 20
10.8333 11.6739 12.5124 13.3476 14.179  15.0071 15.8333 16.6596 17.4877 18.3191 19.1543 19.9928 20.8333
11.6667 12.5163 13.3615 14.199  15.0279 15.8494 16.6667 17.484  18.3055 19.1343 19.9718 20.817  21.6667
12.5    13.3633 14.2183 15.0591 15.8841 16.6958 17.5    18.3042 19.1159 19.9409 20.7817 21.6367 22.5
13.3333 14.2187 15.0893 15.935  16.7537 17.5498 18.3333 19.1169 19.913  20.7316 21.5774 22.4479 23.3333
14.1667 15.089  15.9849 16.8381 17.6457 18.4163 19.1667 19.917  20.6876 21.4952 22.3484 23.2444 24.1667
15      15.9855 16.9233 17.7869 18.5746 19.3032 20      20.6968 21.4254 22.2131 23.0767 24.0145 25
15.8333 16.9299 17.936  18.8115 19.5626 20.2219 20.8333 21.4448 22.104  22.8551 23.7307 24.7368 25.8333
16.6667 17.9646 19.0791 19.9606 20.6425 21.1884 21.6667 22.1449 22.6908 23.3727 24.2542 25.3687 26.6667
17.5    19.1829 20.4554 21.3091 21.8586 22.2224 22.5    22.7776 23.1414 23.6909 24.5446 25.8171 27.5
18.3333 20.8115 22.2504 22.9619 23.2602 23.3428 23.3333 23.3239 23.4065 23.7047 24.4163 25.8552 28.3333
19.1667 23.4794 24.7728 25.0281 24.8775 24.5551 24.1667 23.7783 23.4558 23.3053 23.5605 24.8539 29.1667
20      29.1667 28.3333 27.5    26.6667 25.8333 25      24.1667 23.3333 22.5    21.6667 20.8333 30
```

Выполнение на CPU

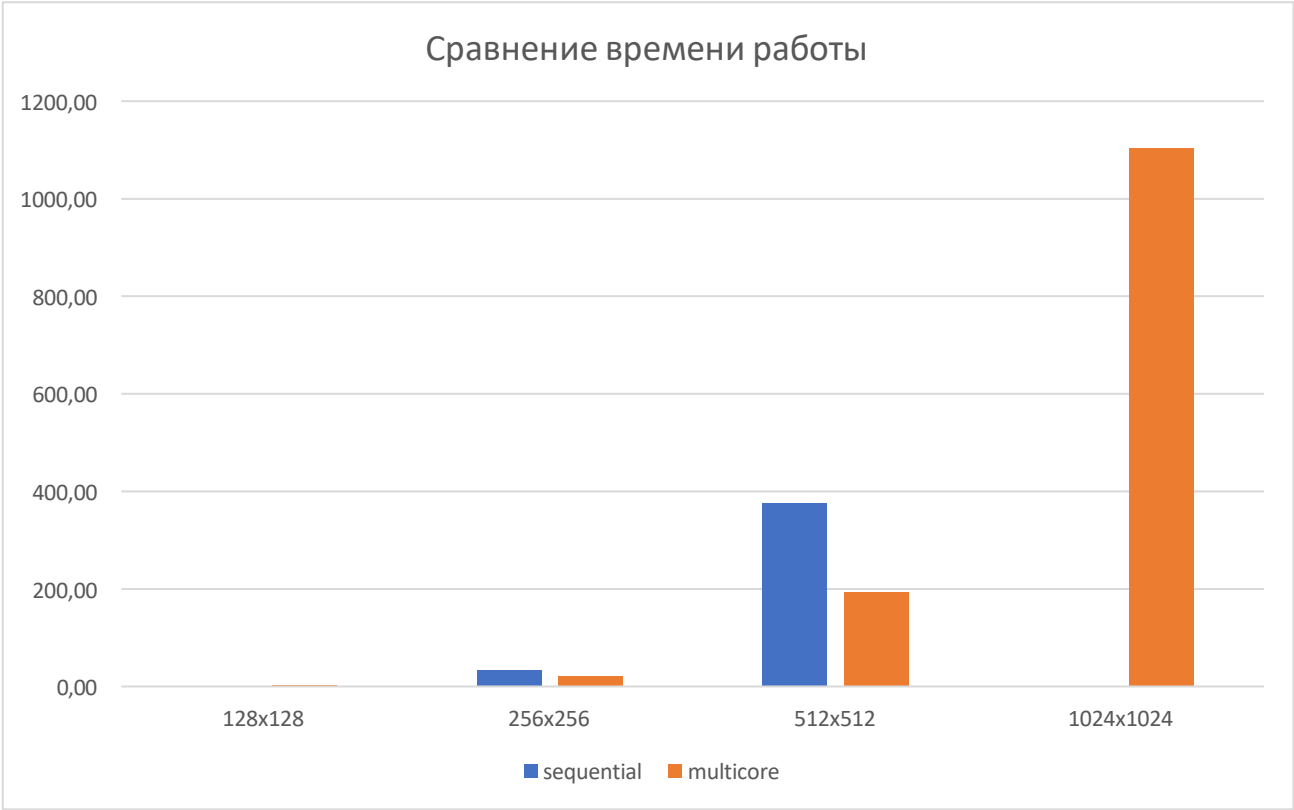
CPU Sequential

Размер сетки	Время	Точность	Кол-во итераций
128x128	1,27	9.99813e-7	43641
256x256	33,10	9.99979e-7	166766
512x512	376,28	9.99997e-7	632912

CPU Multicore

Размер сетки	Время	Точность	Кол-во итераций
128x128	3,58	9.99813e-7	43641
256x256	21,34	9.99979e-7	166766
512x512	194,53	9.99997e-7	632912
1024x1024	1104,84	0,000700391	1000000

Диаграмма сравнения времени выполнения работы



Выполнение на GPU(OpenACC)

Размер сетки	Время	Точность	Кол-во итераций
128x128	4,21	9.99813e-7	43641
256x256	8,62	9.99979e-7	166766
512x512	26,32	9.99997e-7	632912

Результат профилирования

Time (%)	Total Time (ns)	Num Calls	Avg (ns)	Med (ns)	Min (ns)	Max (ns)	StdDev (ns)	Name
11.5	1052415	50	21048.3	20228.5	19584	54420	4842.5	Compute Construct@therm_gpu.cpp:53
11.3	1032924	50	20658.5	19604.0	19202	57836	5680.2	Exit Data@therm_gpu.cpp:53
11.1	1010684	50	20213.7	19491.5	19011	44974	3693.5	Enter Data@therm_gpu.cpp:53
8.3	761995	150	5080.0	6171.0	2315	6986	1946.7	Wait@therm_gpu.cpp:64
8.1	743043	100	7430.4	7335.0	6739	8587	444.2	Wait@therm_gpu.cpp:53
7.7	703604	50	14072.1	13450.0	13144	29359	2859.1	Enqueue Download@therm_gpu.cpp:64
7.6	698431	50	13968.6	13911.5	13489	16391	475.9	Enter Data@therm_gpu.cpp:64
7.6	692593	50	13851.9	13645.0	13096	18557	1017.4	Compute Construct@therm_gpu.cpp:64
5.8	532852	100	5328.5	5181.0	4388	22710	1856.9	Enqueue Launch@therm_gpu.cpp:53
4.5	409298	100	4093.0	4181.5	3306	8080	863.2	Enqueue Upload@therm_gpu.cpp:53
3.2	289864	1	289864.0	289864.0	289864	289864	0.0	Enter Data@therm_gpu.cpp:51
3.1	285566	50	5711.3	5359.0	5062	13176	1343.0	Enqueue Launch@therm_gpu.cpp:64
2.3	211849	50	4237.0	4119.5	3948	6592	419.2	Enqueue Upload@therm_gpu.cpp:64
1.9	174987	1	174987.0	174987.0	174987	174987	0.0	Device Init@therm_gpu.cpp:51
1.6	147573	1	147573.0	147573.0	147573	147573	0.0	Enqueue Upload@therm_gpu.cpp:51
1.6	143719	1	143719.0	143719.0	143719	143719	0.0	Exit Data@therm_gpu.cpp:51
1.5	134310	1	134310.0	134310.0	134310	134310	0.0	Enqueue Download@therm_gpu.cpp:77
1.0	90913	50	1818.3	1801.0	1728	2061	58.9	Exit Data@therm_gpu.cpp:64
0.3	26734	1	26734.0	26734.0	26734	26734	0.0	Wait@therm_gpu.cpp:51
0.0	2767	1	2767.0	2767.0	2767	2767	0.0	Wait@therm_gpu.cpp:77
0.0	0	2	0.0	0.0	0	0	0.0	Alloc@therm_gpu.cpp:51
0.0	0	2	0.0	0.0	0	0	0.0	Alloc@therm_gpu.cpp:53
0.0	0	2	0.0	0.0	0	0	0.0	Create@therm_gpu.cpp:51
0.0	0	100	0.0	0.0	0	0	0.0	Create@therm_gpu.cpp:53
0.0	0	50	0.0	0.0	0	0	0.0	Create@therm_gpu.cpp:64
0.0	0	100	0.0	0.0	0	0	0.0	Delete@therm_gpu.cpp:64
0.0	0	50	0.0	0.0	0	0	0.0	Delete@therm_gpu.cpp:72
0.0	0	2	0.0	0.0	0	0	0.0	Delete@therm_gpu.cpp:77

Выполнение на GPU(cuBLAS)

Размер сетки	Время	Точность	Кол-во итераций
128x128	1,54	9.99813e-7	43641
256x256	5,34	9.99979e-7	166766
512x512	19,19	9.99997e-7	632912

Time (%)	Total Time (ns)	Num Calls	Avg (ns)	Med (ns)	Min (ns)	Max (ns)	StdDev (ns)	Name
18.4	1630233	100	16302.3	15873.0	15237	27113	1824.4	Compute Construct@task.cpp:68
17.6	1558787	100	15587.9	14895.0	14208	62745	4946.5	Compute Construct@task.cpp:48
16.0	1417238	100	14172.4	14082.0	13616	17743	532.5	Compute Construct@task.cpp:57
11.7	1036957	100	10369.6	10098.5	9756	21223	1570.3	Wait@task.cpp:68
11.4	1011462	100	10114.6	9954.5	6969	21863	1290.0	Wait@task.cpp:48
10.4	920990	100	9209.9	9158.0	8945	9688	176.6	Wait@task.cpp:57
4.7	419317	100	4193.2	4047.0	3729	8318	681.6	Enqueue Launch@task.cpp:68
4.3	384118	100	3841.2	3478.0	3200	31207	2790.0	Enqueue Launch@task.cpp:48
4.0	356184	100	3561.8	3480.0	3161	6162	449.3	Enqueue Launch@task.cpp:57
1.2	110221	1	110221.0	110221.0	110221	110221	0.0	Device Init@task.cpp:48

Выполнение на GPU(CUB)

Размер сетки	Время	Точность	Кол-во итераций
128x128	0,21	9.99813e-7	31000
256x256	0,82	9.99979e-7	103000
512x512	4,94	9.99997e-7	340000

Time (%)	Total Time (ns)	Instances	Avg (ns)	Med (ns)	Min (ns)	Max (ns)	StdDev (ns)	Style	Range
92.8	6346569104	1	6346569104.0	6346569104.0	6346569104	6346569104	0.0	PushPop	solving
7.1	487247146	1	487247146.0	487247146.0	487247146	487247146	0.0	PushPop	Init context
0.0	1816836	1	1816836.0	1816836.0	1816836	1816836	0.0	PushPop	update_kernel
0.0	16106	1	16106.0	16106.0	16106	16106	0.0	PushPop	block_max_kernel_reduction
0.0	11476	1	11476.0	11476.0	11476	11476	0.0	PushPop	copy_kernel
[4/8] Executing 'cuda_api_sum' stats report									
Time (%)	Total Time (ns)	Num Calls	Avg (ns)	Med (ns)	Min (ns)	Max (ns)	StdDev (ns)	Name	
81.4	5146055014	340	15135455.9	15204374.5	8395789	15364047	540627.2	cudaMemcpyAsync	
18.4	1163154338	340000	3421.0	3255.0	2921	3343538	12769.3	cudaGraphLaunch_v10000	
0.1	9427858	4	2356964.5	6641.5	1162	9413413	4704300.3	cudaMallocAsync_v11020	
0.0	1835696	4	458924.0	10702.0	875	1813417	903009.2	cudaLaunchKernel	
0.0	1452255	2	726127.5	726127.5	500575	951680	318979.4	cudaMemcpy	
0.0	722334	340	2124.5	1864.5	1660	9810	955.6	cudaStreamSynchronize	
0.0	244089	4	61022.3	3751.5	897	235689	116463.2	cudaFree	
0.0	59183	1	59183.0	59183.0	59183	59183	0.0	cudaGraphInstantiate_v12000	
0.0	29917	1	29917.0	29917.0	29917	29917	0.0	cudaGraphExecDestroy_v10000	
0.0	13226	1	13226.0	13226.0	13226	13226	0.0	cudaStreamCreate	
0.0	12630	1	12630.0	12630.0	12630	12630	0.0	cudaGraphCreate_v10000	
0.0	8215	1	8215.0	8215.0	8215	8215	0.0	cudaStreamDestroy	
0.0	5134	1	5134.0	5134.0	5134	5134	0.0	cudaGraphDestroy_v10000	
0.0	2709	1	2709.0	2709.0	2709	2709	0.0	cudaStreamBeginCapture_v10000	
0.0	2087	1	2087.0	2087.0	2087	2087	0.0	cudaStreamEndCapture_v10000	
0.0	1165	1	1165.0	1165.0	1165	1165	0.0	cuModuleGetLoadingMode	
[5/8] Executing 'cuda_gpu_kern_sum' stats report									
SKIPPED: /tmp/nsys-report-739b.sqlite does not contain CUDA kernel data.									
[6/8] Executing 'cuda_gpu_mem_time_sum' stats report									
Time (%)	Total Time (ns)	Count	Avg (ns)	Med (ns)	Min (ns)	Max (ns)	StdDev (ns)	Operation	
67.0	667775	341	1958.3	1472.0	1439	162495	8719.5	[CUDA memcpy Device-to-Host]	
33.0	328285	1	328285.0	328285.0	328285	328285	0.0	[CUDA memcpy Host-to-Device]	

cuBLAS vs OpenACC vs CUB

