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Radix-2 FFT: Sequential vs Parallel with OpenACC and CUDA
Research Week 5
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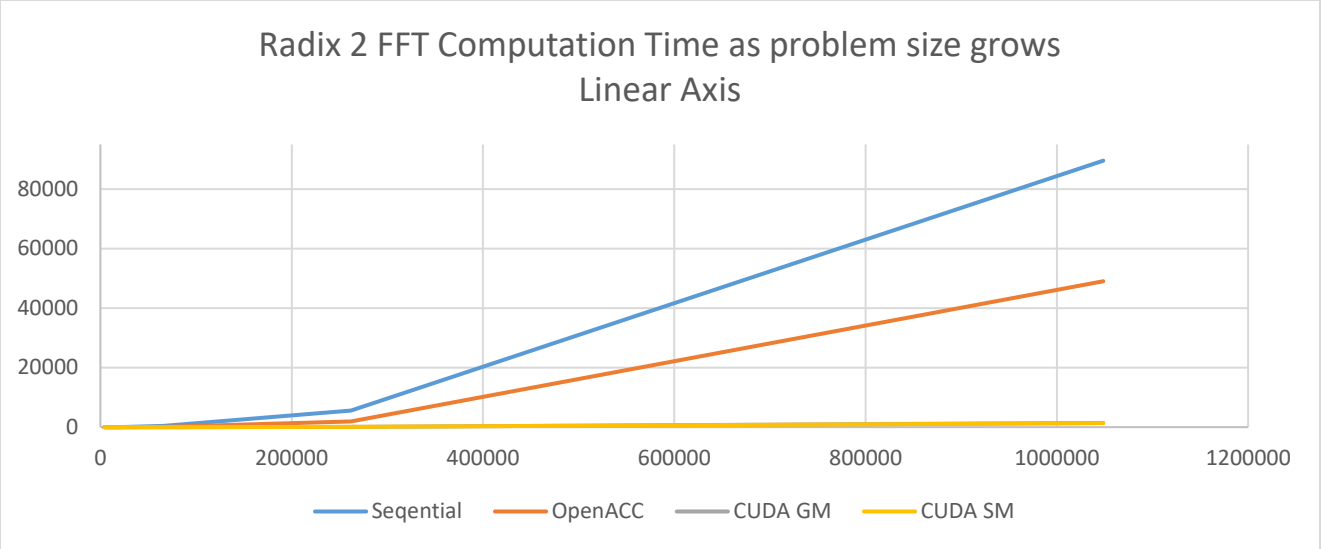
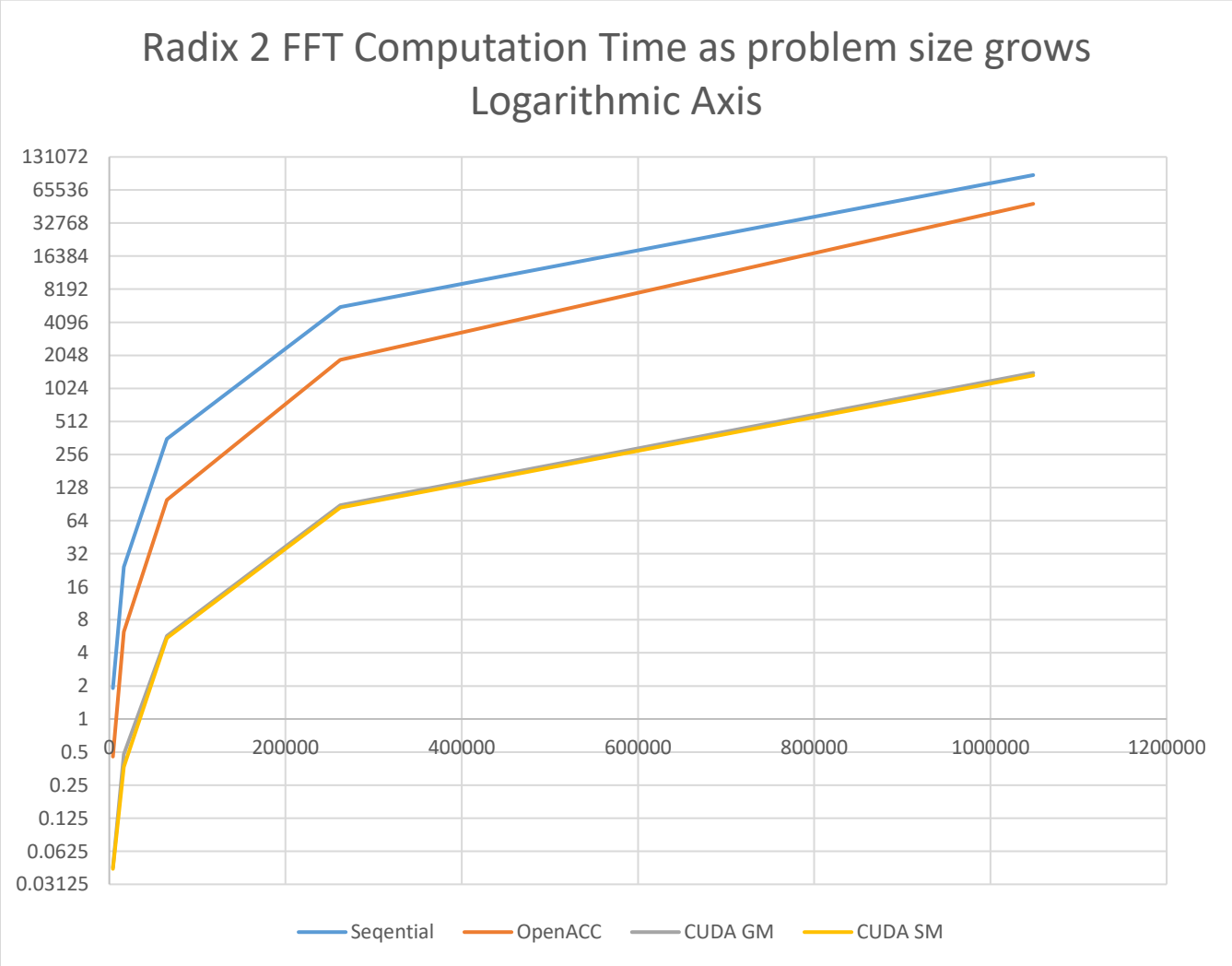
Size/System	Intel Core i3-7100 Dual Core @ 3.90GHz (CPU) Nvidia Geforce GTX 1050 TI (GPU)		
	Method	Speed(seconds)	Speedup(Ts/Tp)
4,096	Sequential	1.907368	
	OpenACC	0.454588	*4.1958 (419.58 %)*
	CUDA Global Memory	0.04443002	*42.929 (4292.9 %)*
	CUDA Shared Memory	0.04316807	*44.184 (4418.6 %)*
16,384	Sequential	24.24149	
	OpenACC	6.214528	*3.9 (390 %)*
	CUDA Global Memory	0.477581	*50.758 (5075.8 %)*
	CUDA Shared Memory	0.3654189	*66.338 (6633.8 %)*
65,536	Sequential	355.5284	
	OpenACC	98.96123	*3.592 (359.2 %)*
	CUDA Global Memory	5.696616	*62.41 (6241 %)*
	CUDA Shared Memory	5.450865	*65.224 (6522.4 %)*
262,144	Sequential	5617.434	
	OpenACC	1864.156	*3.013 (301.3 %)*
	CUDA Global Memory	88.55316	*63.435 (6343.5 %)*
	CUDA Shared Memory	83.92049	*66.936 (6393.7 %)*
1,048,576	Sequential	89563.81	
	OpenACC	49027.96	*1.826 (182.6 %)*
	CUDA Global Memory	1415.992	*63.251 (6325.1 %)*
	CUDA Shared Memory	1343.394	*66.669 (6666.9 %)*

There is a very significant speedup with the massively parallel approach (up to 66.9x) when using CUDA and shared memory in the GPU as recorded in the table above. The openACC approach is definitely faster than the sequential approach but not as fast as expected. The maximum speedup recorded using openACC was 4.19x, slowly decreasing as the problem size grows.

The openACC approach was no where near as fast as the optimized CUDA approach even when taking advantage of shared memory using OpenACC. This behavior was expected but not to that extent, as openACC was slower than optimized CUDA code when multiplying matrices but was at least 0.5x as fast CUDA Global Memory code, which is not the case when solving a radix-2 FFT due to the nature of the problem.

Additionally, using shared memory to solve the problem did not provide a significant performance boost. However, it did provide a minor boost (1.3x faster than the global memory code).


Radix 2 FFT Computation Time as problem size grows
Linear Axis
80000
60000
40000
20000
0
0
200000
400000
600000
800000
1000000
1200000
Seqential
OpenACC
CUDA GM
CUDA SM


Radix 2 FFT Computation Time as problem size grows
Logarithmic Axis
131072
65536
32768
16384
8192
4096
2048
1024
512
256
128
64
32
16
8
4
2
1
0.5
0.25
0.125
0.0625
0.03125
0
200000
400000
600000
800000
1000000
1200000
Seqential
OpenACC
CUDA GM
CUDA SM