Weekly Report

LIU Honghao

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1 Experiment

1.1 Hardware info

CPU information:
Name: Intel(R) Xeon(R) Gold 5218 CPU @ 2.30GHz
Thread Number: 64
Memory size: 512G
GPU info:
Name: Tesla V100-SXM2-32GB
Global memory: 32GB,**Shared memory per block:** 49KB

1.2 Results

Compared nonuniform Fourier transform between different methods. All methods are ran in 10 times and get the average values of time.

1.2.1 Notations

N - number of uniformly distributed points
M - number of non-uniformly distributed points
Methods:

1 cufinufft, GPU version using global memory, using cufft for fast Fourier transform.

2 cufinufft, GPU version using shared memory, using cufft for fast Fourier transform.

3 finufft, CPU version with 64 threads (max threads) parallelized by openMP, using FFTW for fast Fourier transform.

4 finufft, CPU version with 32 threads (one thread per core) parallelized by openMP, using FFTW for fast Fourier transform.

Tol - tolerance, the maximum l^2 error for one point (defined as equ. 1) can bear. C is the exactly correct value. c_r is the result calculated by NUFFT. Both C and c_r are complex numbers.

$$err = \frac{|C - c_r|}{\max\{|c_i|\}} \tag{1}$$

MemTrans - time for transferring data between host and to device.

Plan - plan time for some preparation operations like correction factor calculation, memory allocation for plan related information.
Exce - execution time for spreading, FFT and correction.
For direction, there are two types, inverse - from NUPTS to UPTS, forward - UPTS to NUPTS.

1.2.2 Statistics

N	**M** (NUPTS)	**Method**	**MemTrans**	**(Plan+)Exec**	**Total time**
512*512	512*512	1	0.0012	**0.0168** + 0.001	0.0195
		2	0.001	0.0169 + 0.0007	**0.0192**
		3			0.0464
		4			0.0243
1024*1024	1024*1024	1	0.005	**0.017** + 0.0037	0.0267
		2	0.004	**0.017** + 0.0026	**0.025**
		3			0.116
		4			0.063
1024*1024	10000 * 10000	1	0.277	0.0174 + 0.21	0.521
		2	0.277	0.0173 + 0.159	**0.47**
		3			1.69
		4			2.07
10000*10000	10000 * 10000	1	0.45	0.0344 + 0.41	0.964
		2	0.45	0.0332 + 0.29	**0.844**
		3			5.11
		4			4.9
10000 * 10000	10000 * 20000	1	0.753	0.646	1.57
		2	0.838	0.619	**1.34**
		3			7.11
		4			7.43
10000 * 10000	10000 * 40000	1	1.33	1.37	3.06
		2	1.28	0.781	**2.41**
		3			11
		4			12

Table 1: Running time with different methods and input size, precision: double, tolerance: 10^{-6}, direction: inverse.

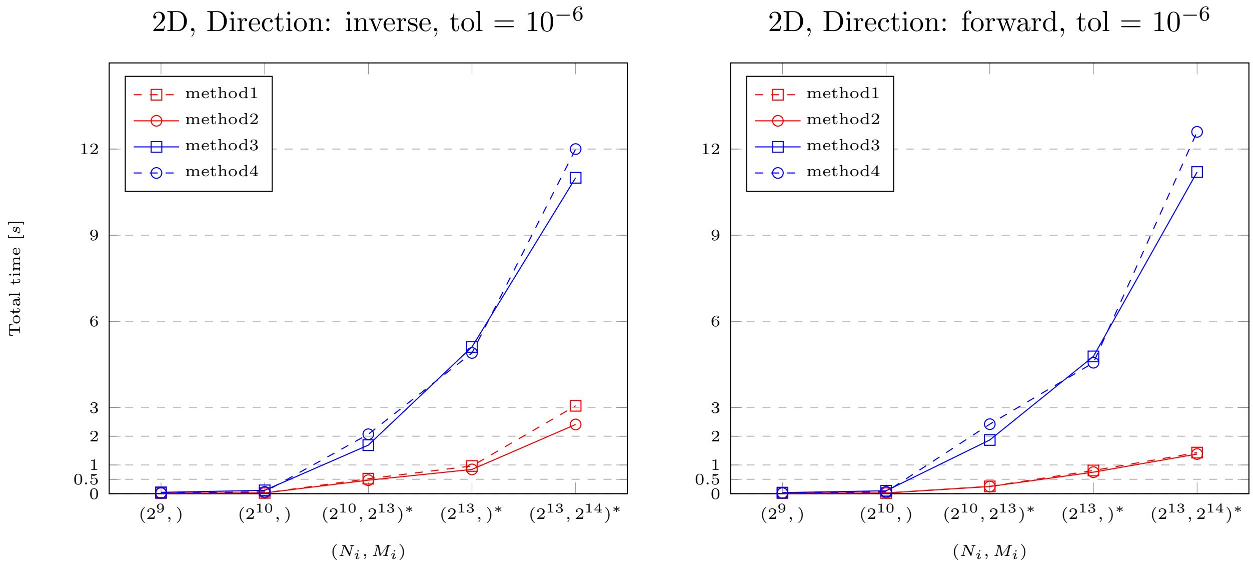
When the number of non-uniform points up to $5 * 10^8$, the memory is insufficient for spreading in GPU version, $5 * 10^9$ for CPU. Table 2 shows running time of larger input size executing in CPU.

N	**M** (NUPTS)	**Total time**
10000*10000	$5 * 10^8$	13.1
	$7 * 10^8$	16.8
	10^9	22.8
	$5 * 10^9$	error

Table 2: Running time with different input size, tolerance is 10^{-6}.

N	**M** (NUPTS)	**Method**	**MemTrans**	**(Plan+)Exec**	**Total time**
512*512	512*512	1	0.0012	**0.0179** + 0.0005	0.0201
		2	0.001	**0.0166** + 0.0004	**0.0186**
		3			0.0367
		4			0.0239
1024*1024	1024*1024	1	0.005	**0.0167** + 0.002	0.0246
		2	0.0047	**0.0168** + 0.0016	**0.0239**
		3			0.101
		4			0.0637
1024*1024	10000 * 10000	1	**0.13**	0.017 + 0.0903	0.254
		2	**0.13**	0.0182 + 0.0841	**0.249**
		3			1.87
		4			2.42
10000*10000	10000 * 10000	1	**0.45**	0.033 + 0.255	0.808
		2	**0.45**	0.033 + 0.195	**0.749**
		3			4.78
		4			4.56
10000 * 10000	10000 * 20000	1	**0.487**	0.307	0.96
		2	**0.487**	0.279	**0.931**
		3			6.91
		4			7.41
10000 * 10000	10000 * 40000	1	**0.645**	0.498	1.43
		2	**0.645**	0.449	**1.38**
		3			11.2
		4			12.6

Table 3: Running time with different methods and input size, the precision is double, tolerance is 10^{-6}, direction is forward.



2D, Direction: inverse, tol = 10^{-6}

2D, Direction: forward, tol = 10^{-6}

Figure 1: Running with different input size.

Tol	Method	Direction	Total time
10^{-1}	1	inverse	0.755
	2		0.75
	3		4.66
	4		4.15
	1	forward	0.777
	2		0.743
	3		4.24
	4		3.84
10^{-3}	1	inverse	0.799
	2		0.766
	3		4.7
	4		4.32
	1	forward	0.786
	2		0.744
	3		4.29
	4		3.9
10^{-6}	1	inverse	0.963
	2		0.843
	3		5
	4		4.8
10^{-6}	1	forward	0.809
	2		0.749
	3		4.72
	4		4.69
10^{-9}	1	inverse	1.21
	2		1
	3		5.63
	4		5.93
	1	forward	0.843
	2		0.792
	3		5.55
	4		5.94
10^{-12}	1	inverse	1.54
	2		1.34
	3		14.1
	4		10.9
	1	forward	0.918
	2		0.901
	3		13.7
	4		10.6

Table 4: Running time with different tolerance and methods

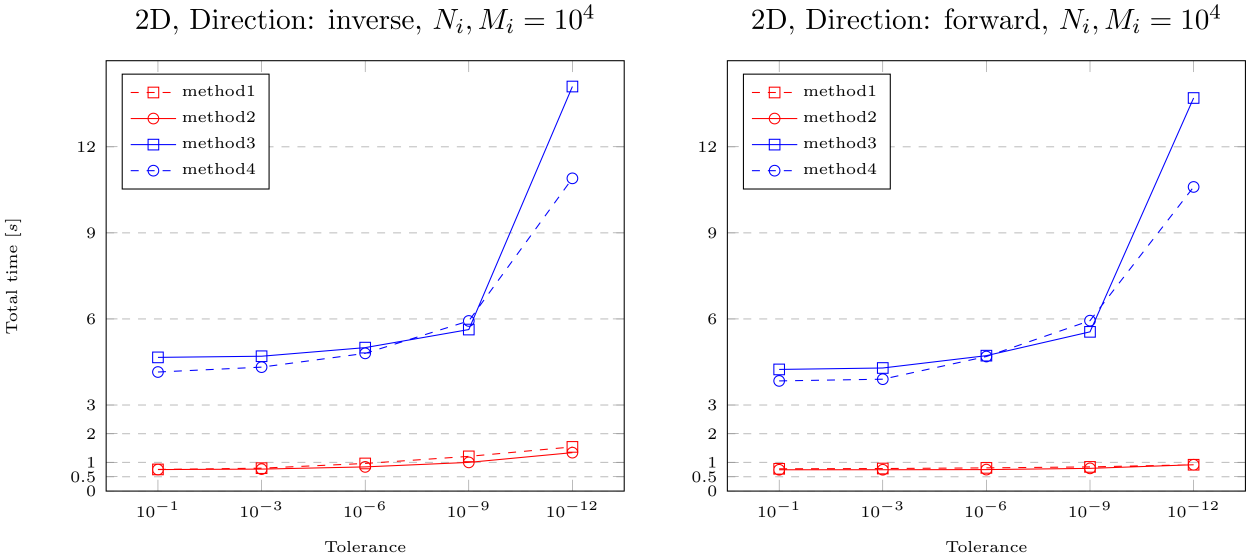


Figure 2: Running time with different tolerance.