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Computer Architecture II
Programming Assignment 4

Results

Matrix Size	Reference C implementation (Single thread)	Normal Kernel	Tiled kernel (Tile size = 8)	Tiled kernel (Tile size = 16)	Normal Kernel	Tiled kernel (Tile size = 8)	Tiled kernel (Tile size = 16)
512 x 512	0.770361	0.00748778	0.0185985	0.017144	0.0105912	0.0116807	0.0186161
1024 x 1024	7.08684	0.125473	0.154348	0.135643	0.0884573	0.0928137	0.0155916
2048 x 2048	203.92	4.46267	1.63644	1.25283	0.934852	0.743764	1.24391

CPU Model Info

```
$lscpu

Architecture:          x86_64
CPU op-mode(s):        32-bit, 64-bit
Byte Order:            Little Endian
CPU(s):                8
On-line CPU(s) list:   0-7
Thread(s) per core:    2
Core(s) per socket:    4
Socket(s):             1
NUMA node(s):          1
Vendor ID:             GenuineIntel
CPU family:            6
Model:                 94
Model name:            Intel(R) Core(TM) i7-6700 CPU @ 3.40GHz
```

```
Stepping:             3
CPU MHz:                900.050
CPU max MHz:           4000.0000
CPU min MHz:           800.0000
BogoMIPS:              6816.00
Virtualization:       VT-x
L1d cache:             32K
L1i cache:            32K
L2 cache:             256K
L3 cache:             8192K
NUMA node0 CPU(s):     0-7
```

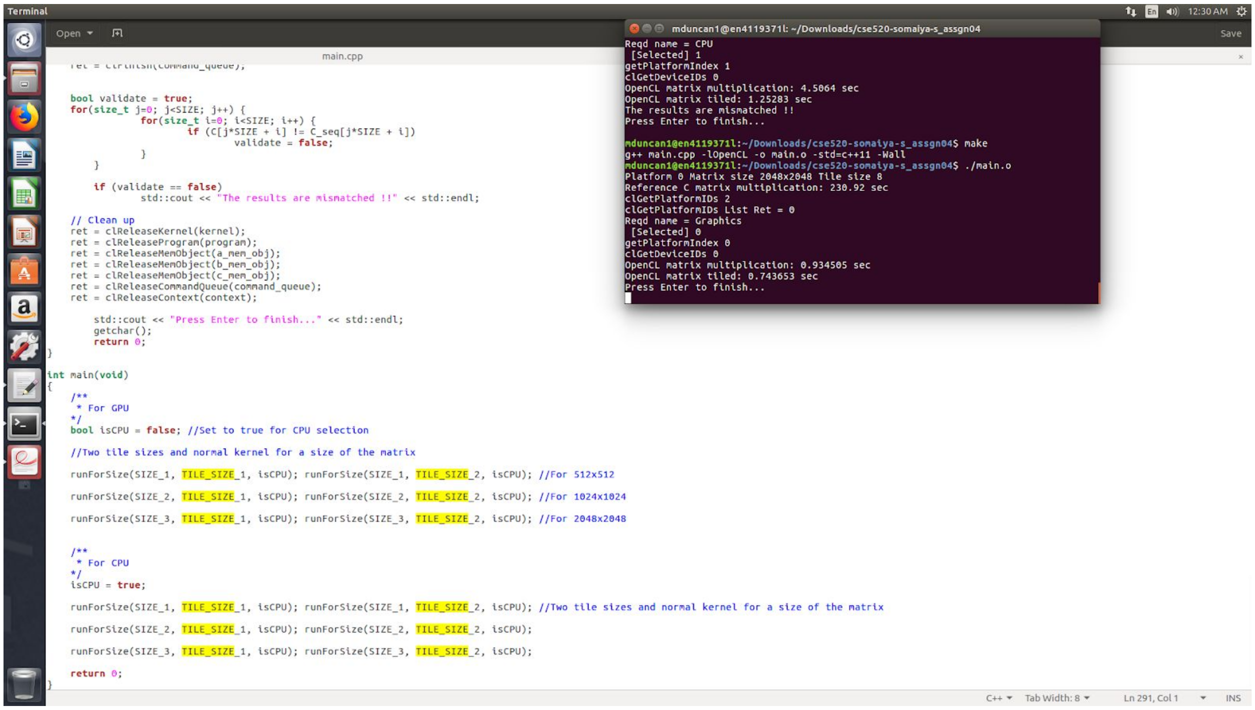
GPU Model Info

$ lspci | grep VGA

Intel Corporation Sky Lake Integrated Graphics (rev 06)

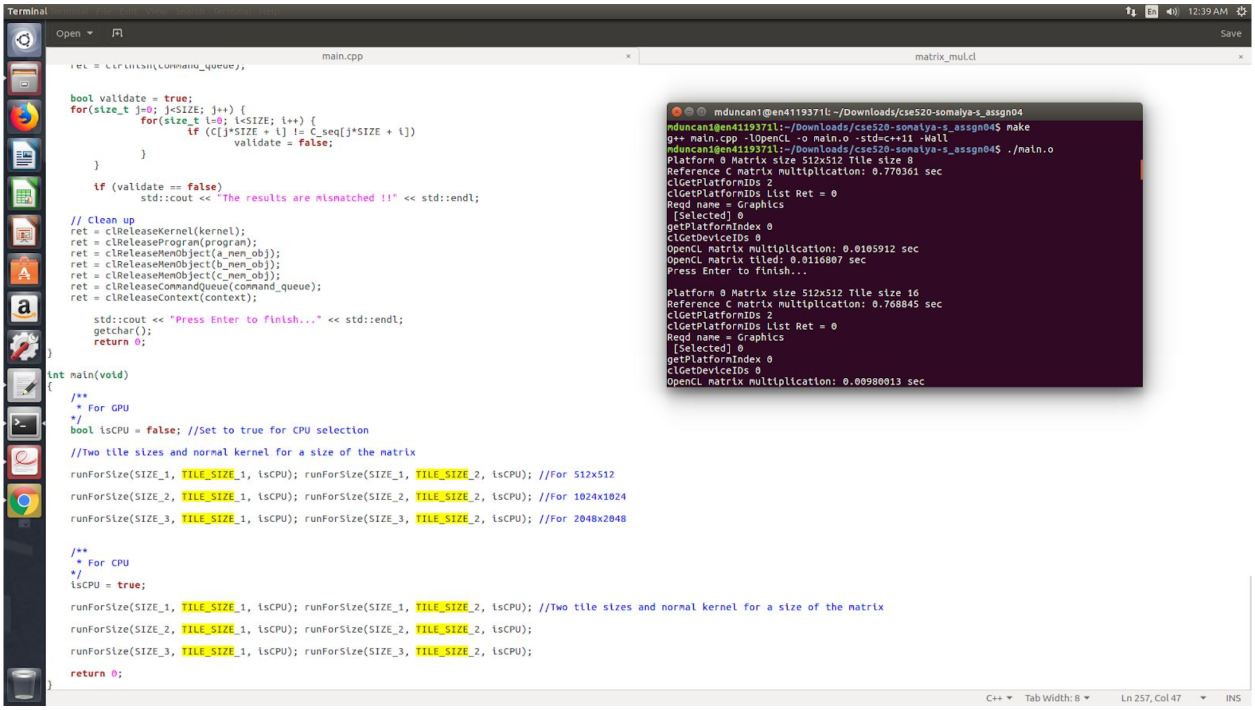
Screenshot from the test

Note: In the following picture, please ignore the “Results are mismtached” from the previous execution



```
    ret = clFinish(command_queue);


    bool validate = true;
    for(size_t j=0; j<SIZE; j++) {
                for(size_t i=0; i<SIZE; i++) {
                        if (C[j*SIZE + i] != C_seq[j*SIZE + i])
                                validate = false;
                }
        }

        if (validate == false)
                std::cout << "The results are mismatched !!" << std::endl;

    // Clean up
    ret = clReleaseKernel(kernel);
    ret = clReleaseProgram(program);
    ret = clReleaseMemObject(a_mem_obj);
    ret = clReleaseMemObject(b_mem_obj);
    ret = clReleaseMemObject(c_mem_obj);
    ret = clReleaseCommandQueue(command_queue);
    ret = clReleaseContext(context);

        std::cout << "Press Enter to finish..." << std::endl;
        getchar();
        return 0;
}

int main(void)
{
    /**
     * For GPU
    */
    bool isCPU = false; //Set to true for CPU selection

    //Two tile sizes and normal kernel for a size of the matrix

    runForSize(SIZE_1, TILE_SIZE_1, isCPU); runForSize(SIZE_1, TILE_SIZE_2, isCPU); //For 512x512

    runForSize(SIZE_2, TILE_SIZE_1, isCPU); runForSize(SIZE_2, TILE_SIZE_2, isCPU); //For 1024x1024

    runForSize(SIZE_3, TILE_SIZE_1, isCPU); runForSize(SIZE_3, TILE_SIZE_2, isCPU); //For 2048x2048


    /**
     * For CPU
    */
    isCPU = true;

    runForSize(SIZE_1, TILE_SIZE_1, isCPU); runForSize(SIZE_1, TILE_SIZE_2, isCPU); //Two tile sizes and normal kernel for a size of the matrix

    runForSize(SIZE_2, TILE_SIZE_1, isCPU); runForSize(SIZE_2, TILE_SIZE_2, isCPU);

    runForSize(SIZE_3, TILE_SIZE_1, isCPU); runForSize(SIZE_3, TILE_SIZE_2, isCPU);

    return 0;
}
```

```
Reqd name = CPU
 [Selected] 1
getPlatformIndex 1
clGetDeviceIDs 0
OpenCL matrix multiplication: 4.5064 sec
OpenCL matrix tiled: 1.25283 sec
The results are mismatched !!
Press Enter to finish...

mduncan1@en4119371l:~/Downloads/cse520-somaiya-s_assgn04$ make
g++ main.cpp -lOpenCL -o main.o -std=c++11 -Wall
mduncan1@en4119371l:~/Downloads/cse520-somaiya-s_assgn04$ ./main.o
Platform 0 Matrix size 2048x2048 Tile size 8
Reference C matrix multiplication: 230.92 sec
clGetPlatformIDs 2
clGetPlatformIDs List Ret = 0
Reqd name = Graphics
 [Selected] 0
getPlatformIndex 0
clGetDeviceIDs 0
OpenCL matrix multiplication: 0.934505 sec
OpenCL matrix tiled: 0.743653 sec
Press Enter to finish...
```



Terminal
Terminal File Edit View Search Terminal Help
12:39 AM
Open
Save
main.cpp
matrix_mul.cl
mduncan1@en4119371l: ~/Downloads/cse520-somaiya-s_assgn04
C++
Tab Width: 8
Ln 257, Col 47
INS

```
    ret = clFinish(command_queue);


    bool validate = true;
    for(size_t j=0; j<SIZE; j++) {
                for(size_t i=0; i<SIZE; i++) {
                        if (C[j*SIZE + i] != C_seq[j*SIZE + i])
                                validate = false;
                }
        }

        if (validate == false)
                std::cout << "The results are mismatched !!" << std::endl;

    // Clean up
    ret = clReleaseKernel(kernel);
    ret = clReleaseProgram(program);
    ret = clReleaseMemObject(a_mem_obj);
    ret = clReleaseMemObject(b_mem_obj);
    ret = clReleaseMemObject(c_mem_obj);
    ret = clReleaseCommandQueue(command_queue);
    ret = clReleaseContext(context);

        std::cout << "Press Enter to finish..." << std::endl;
        getchar();
        return 0;
}

int main(void)
{
    /**
     * For GPU
    */
    bool isCPU = false; //Set to true for CPU selection

    //Two tile sizes and normal kernel for a size of the matrix

    runForSize(SIZE_1, TILE_SIZE_1, isCPU); runForSize(SIZE_1, TILE_SIZE_2, isCPU); //For 512x512

    runForSize(SIZE_2, TILE_SIZE_1, isCPU); runForSize(SIZE_2, TILE_SIZE_2, isCPU); //For 1024x1024

    runForSize(SIZE_3, TILE_SIZE_1, isCPU); runForSize(SIZE_3, TILE_SIZE_2, isCPU); //For 2048x2048


    /**
     * For CPU
    */
    isCPU = true;

    runForSize(SIZE_1, TILE_SIZE_1, isCPU); runForSize(SIZE_1, TILE_SIZE_2, isCPU); //Two tile sizes and normal kernel for a size of the matrix

    runForSize(SIZE_2, TILE_SIZE_1, isCPU); runForSize(SIZE_2, TILE_SIZE_2, isCPU);

    runForSize(SIZE_3, TILE_SIZE_1, isCPU); runForSize(SIZE_3, TILE_SIZE_2, isCPU);

    return 0;
}
```

```
mduncan1@en4119371l:~/Downloads/cse520-somaiya-s_assgn04$ make
g++ main.cpp -lOpenCL -o main.o -std=c++11 -Wall
mduncan1@en4119371l:~/Downloads/cse520-somaiya-s_assgn04$ ./main.o
Platform 0 Matrix size 512x512 Tile size 8
Reference C matrix multiplication: 0.770361 sec
clGetPlatformIDs 2
clGetPlatformIDs List Ret = 0
Reqd name = Graphics
 [Selected] 0
getPlatformIndex 0
clGetDeviceIDs 0
OpenCL matrix multiplication: 0.0105912 sec
OpenCL matrix tiled: 0.0116807 sec
Press Enter to finish...

Platform 0 Matrix size 512x512 Tile size 16
Reference C matrix multiplication: 0.768845 sec
clGetPlatformIDs 2
clGetPlatformIDs List Ret = 0
Reqd name = Graphics
 [Selected] 0
getPlatformIndex 0
clGetDeviceIDs 0
OpenCL matrix multiplication: 0.00980013 sec
```