

Programming Assignment VI: OpenCL Programming

The purpose of this assignment is to familiarize yourself with OpenCL programming.

1 Problem Statement

A histogram is a statistic that shows frequency of a certain occurrence within a data set. The histogram of an image provides a frequency distribution of pixel values in the image. If the image is a color image, the pixel value can be the luminosity value of each pixel or the individual red (R), green (G), and blue (B). More about image histogram can be found at http://en.wikipedia.org/wiki/Image_histogram.

In this problem, you need to use OpenCL to parallelize the implementation of the image histogram, which needs to calculate the pixel values (RGB) in an image. The input is a one-dimension array consisting the R/G/B values, each of which ranges from 0 to 255, of each pixel of the image.

Below shows a serial implementation of the image histogram. The implementation can be downloaded at <http://people.cs.nctu.edu.tw/~ypyou/courses/PP-f18/assignments/HW5/image-histogram.cpp>.

```
#include "stdio.h"
#include "stdlib.h"
#include "string.h"
#include <fstream>
#include <iostream>

unsigned int * histogram(unsigned int *image_data, unsigned int _size)
{
    unsigned int *img = image_data;
    unsigned int *ref_histogram_results;
    unsigned int *ptr;

    ref_histogram_results = (unsigned int *)malloc(256 * 3 * sizeof
        (unsigned int));
    ptr = ref_histogram_results;
    memset (ref_histogram_results, 0x0, 256 * 3 * sizeof(unsigned
        int));

    // histogram of R
    for (unsigned int i = 0; i < _size; i += 3)
    {
        unsigned int index = img[i];
        ptr[index]++;
    }

    // histogram of G
    ptr += 256;
    for (unsigned int i = 1; i < _size; i += 3)
    {
        unsigned int index = img[i];
        ptr[index]++;
    }

    // histogram of B
    ptr += 256;
    for (unsigned int i = 2; i < _size; i += 3)
    {
        unsigned int index = img[i];
        ptr[index]++;
    }
}
```

```

        return ref_histogram_results;
    }

int main(int argc, char const *argv[])
{
    unsigned int * histogram_results;
    unsigned int i=0, a, input_size;
    std::fstream inFile("input", std::ios_base::in);
    std::ofstream outFile("xxxxxx.out", std::ios_base::out);

    inFile >> input_size;
    unsigned int *image = new unsigned int[input_size];
    while( inFile >> a ) {
        image[i++] = a;
    }

    histogram_results = histogram(image, input_size);
    for(unsigned int i = 0; i < 256 * 3; ++i) {
        if (i % 256 == 0 && i != 0)
            outFile << std::endl;
        outFile << histogram_results[i]<< ' ';
    }

    inFile.close();
    outFile.close();

    return 0;
}

```

2 Input/Output

2.1 Input

The first line represents the size of the one-dimension array, say N , followed by $N/3$ lines, each of which indicates a list of R, G, and B values (separated by a space) of a pixel. The following example indicates that the input image has three pixels, values of which are (255 0 0), (0 100 255), and (255 255 255), respectively.

```

9
255 0 0
0 100 255
255 255 255

```

2.2 Output

You will need to output a file, named `StudentID.out`, which contains the values pointed by `ref_histogram_results` in the sample code. The output file contain three lines for the R/G/B values, respectively, and each line contains 256 values separated by a space.

3 Requirements

- Your submitted solution contains two source files, which are named `histogram.cpp` and `histogram.cl`.
- The `histogram.cl` must be the OpenCL kernel that you wrote.

4 Development Environment

4.1 Building the OpenCL environment on your own computer

If you have a nVidia or AMD GPU, you can build your own development environment by installing the corresponding SDK.

<https://developer.nvidia.com/cuda-downloads>

<http://developer.amd.com/tools-and-sdks/heterogeneous-computing/amd-accelerated-parallel-processing-app-sdk/downloads/>

4.2 Using CUDA/OpenCL Server in SSLAB

We have set up four servers (the same servers as described in the last assignment) for this assignment. You can login to one of the servers to work on your assignment. Each server contains a GeForce GTX 1060 GPU. TAs will grade your implementation on these servers, so please make sure your implementation works on the provided servers.

4.2.1 Login

Server IP: 140.113.215.195

Port: 37011, 37013, 37014, 37015

Account: pp+Your Student ID

Password: pp+Your Student ID

4.2.2 Compilation

```
g++ -lOpenCL histogram.cpp -o histogram
```

If the message below shows, do not bother with it. The OpenCL environment works as expected.
"/opt/cuda/lib64/libOpenCL.so.1: no version information available"

5 Submission

Be sure to upload your zipped source codes, which includes no folder, to e-Campus system by the due date and name your file as "HW5_XXXXXXX.zip", where XXXXXXX is your student ID.

Due Date: 23:59, December 21, 2018

6 References

- <http://www.kimicat.com/opencl-1/opencl-jiao-xue-yi>
- <http://www.khronos.org/opencl/>