Assignment2 Mandelbrot Set Computation

Due:2022/10/31 23:59

Description

Set of points in a complex plane that are quasi-stable (will increase and decrease, but not exceed some limt) when computed by iterating the function:

$$Z_{k+1} = Z_k^2 + c \tag{1}$$

When Z_{k+1} is the $(k+1)_{th}$ iteration of the complex number $Z = a + bi$ and is a complex number giving the position of the point in the complex plan. (For example, in a image of height $H$and width W, $c = \frac{x - height/2}{height/4} + \frac{y - width/2}{width/4} \times i$. You can also scale the c to obtain a different output).

The initial value for Z_0 is zero. The iterations continued until the magnitude of Z_k is greater than a threshold or the maximum number of iterations have been achieved. For $Z_k = a + bi$. The magnitude of is defined below:

$$Z_k = \sqrt{a^2 + b^2} \tag{2}$$

Computing the complex function $Z_{k+1} = Z_k^2 + c$ is simplfied by recognizing that:

$$Z^2 = a^2 + 2abi + bi^2 = a^2 - b^2 + 2abi \tag{3}$$

Therefore, real part is the real part is $a^2 - b^2$ while the imaginary part is $2abi$. The next iteration values can be produced by computing:

$$Z_{real} = Z_{real}^2 - Z_{imag}^2 + c_{real} Z_{imag} = 2ZrealZimag + c_{imag} \tag{4}$$

You need to design your own method to partition the image and assign pixels to different threads or processes. For visualizing the Mandelbrot Set on an image, compute Z_k for each pixels. If Z_k is quasi-stable, draw this pixel on the display using asg2 (where template is uploaded to bb) or Xlib (where template is uploaded to http://www.cs.nthu.edu.tw/~ychung/homework/para_programming/seq_mandelbrot_c.htm.)

Requirement

- You need to implement two versions of the tasks, which are MPI version and a Pthread version. And hand in the codes for these two versions in two seperate code files.
- In your submit code, it should display an image with size of 800 × 800.
- Include the results in your report.
- You need to specify the command line about how to compile and run your program.
- You need to compare the performance of different implementation and configurations in your report.
    a. The number of processes or threads used in the program
    b. MPI vs Sequential vs Pthread
    c. Size of the output images (three different sizes ranging from small, medium to large)
    d. More if you have

- You need to include two figures describing the structure of your MPI program and Pthread program.
- The report should be in appropriate format, with a title page, introduction session to introduce the basic problem and task, method session to describe your parallel implementation, result session to compare performance under different configurations, and a conclusion session which concludes your experiment results.

Tips

When measuring the running time of the program, make sure only measure the computation time. (Because asg2 or xlib's drawing are time consuming.)

You should start your homework as soon as possible, do not try to finish it in the last two days before the deadline.

Debug your program on the VM that is built on the image centos. Make sure the program is OK

Make sure use ‘sbatch’ command to submit your jobs onto the master machine, do not directly run your program on the master machine.

Try to limit your program running time within 60 seconds. If your program is running slow, try to improve your code or reduce the image’s size.

If you are using xlib to draw the image. Remember to add a -lX11 flag when compiling your code.

Where and What to Turn in Your Homework

Please turn in a zip file includes

- report
- code

zip your source codes and paper in a zip file, and name it studentID.zip, then submit it on Black board.

Late submission penalty, 5 points deduction for each 12 hours after the deadline. We will not mark your assignment if your submission is 24 hours late.