

1 Overview

1.1 Location \$(AMDAPPSDKSAMPLESROOT)\samples\aparapi\examples

1.2 How to Run See the *Getting Started* guide for how to build samples. You first must compile the sample.

Use the command line to change to the directory where the executable is located. The pre-compiled sample jar is at \$(AMDAPPSDKSAMPLESROOT)\samples\aparapi\examples\Mandel\

Under Windows, type the following command(s).

1. mandel.bat
This runs the program.
2. mandel.bat -h
This prints the help file.

Under Linux, type the following command(s).

1. ./mandel.sh
This runs the program.
2. ./mandel.sh -h
This prints the help file.

1.3 Command Line Options Table 1 lists, and briefly describes, the command line options.

Table 1 Command Line Options

Short Form	Long Form	Description
-h	--help	Shows all command options and their respective meaning.
-q	--quiet	Quiet mode. Suppresses all text output.
-e	--verify	Verify results against reference implementation.
-t	--timing	Print timing.
-v	--version	AMD APP SDK version string.
-x	--exec_plat	Execution platform [CPU GPU JAVAST JAVAMT]

2 Introduction

Mandelbrot-set images are generated by

1. taking a complex number
2. checking if it tends to infinity when the formula is iterated on that number
3. using the number as X and Y coordinates in the picture
4. coloring the pixel depending on whether it tends to infinity or not.

A Mandelbrot set is a set of values of c in the complex plane for which the orbit of 0 under iteration of the complex quadratic polynomial $z_{n+1} = z_n^2 + c$ remains bounded. That is, a complex number c is part of the Mandelbrot set if, when starting with $z_0 = 0$ and applying the iteration repeatedly, the absolute value of z_n remains bounded however large n gets.

The definition of the Mandelbrot set along with its basic properties can be used to draw a picture. The region of the complex plane under consideration is subdivided into a certain number of pixels. To color a pixel, let c be the midpoint of that pixel; then, iterate the critical point 0 under P_c , and check at each step if the orbit point has a modulus larger than 2.

- If it does, then c does not belong to the Mandelbrot set, and color the pixel according to the number of iterations that was used to find out.
- If it does not, iterate up to a fixed number of steps, then decide that the parameter is “probably” in the Mandelbrot set, or at least very close to it, and color the pixel black.

3 Implementation Details

This example starts with a Mandelbrot image of a specific scale (default-scale), pauses for several seconds, then zooms in for 128 frames; finally, it zooms out to the image it started with. It supports four modes of execution: GPU, CPU (using Aparapi), Java single thread, and Java multi-thread. The sample does not override `Kernel.run()`; instead, it uses an OpenCL kernel in the `Mandel.cl` file by creating a `MandelBrot` interface that extends `OpenCL<MandelBrot>`. The location of the OpenCL kernel is specified by `@OpenCL.Resource()`. `JavaMandelBrot.java` has Java single-thread implementation of the same kernel as in `Mandel.cl`, while `JavaMandelBrotMultiThread.java` has a multi-threaded implementation of the kernel.

In case the `--quiet` or `--verify` option is used, the zoom-in point is generated randomly; otherwise, it waits for users to click on the image, then zooms in at the clicked point.

4 Recommended Input Option Settings

For best performance, enter the following on the command line: `-x GPU -q -t`

5 Requirements

To build/run the Aparapi example requires the following environment:

- Set `JAVA_HOME` to the directory containing JRE/JDK, version 1.7 or above.
- Set `ANT_HOME` to the directory containing ANT, version 1.8 or above.

- Set `LIBAPARAPI` to the directory where [aparapi-2012-11-14.zip](#) (or [above](#)) is unzipped.
- Ensure that `PATH` is set such that `java` & `javac` executables are used from JDK version 1.7 or above and `ant` executable is used from `ANT_HOME`.
- In Linux, set `LD_LIBRARY_PATH` to the directory where [aparapi-2012-11-14.zip](#) (or [above](#)) is unzipped.

6 References

1. http://en.wikipedia.org/wiki/Mandelbrot_set
2. <http://code.google.com/p/aparapi/>

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