AMD **Accelerated** Parallel Processing
TECHNOLOGY

SAMPLE

Mandelbrot

1 Overview

This sample supports both scalar and vector versions of the kernel. The host program makes a decision at runtime as to which version to run base on the GPU (for Southern Islands, it is scalar; for Evergreen and Northern Islands, it is vector).

1.1 Location

`$(AMDAPPSDKSAMPLESROOT)\samples\opencl\cl\app`

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 precompiled sample executable is at `$(AMDAPPSDKSAMPLESROOT)\samples\opencl\bin\x86\` for 32-bit builds, and `$(AMDAPPSDKSAMPLESROOT)\samples\opencl\bin\x86_64\` for 64-bit builds.

Type the following command(s).

1. `Mandelbrot`
   This sorts an array of 64 randomly generated numbers.
2. `Mandelbrot -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.
	`--device`	Devices on which the program is to be run. Acceptable values are `cpu`, `gpu`., or `all`.
	`--vector`	Selects the vector version of the kernel to run.
	`--scalar`	Selects the scalar version of the kernel to run.
`-q`	`--quiet`	Quiet mode. Suppresses all text output.
`-e`	`--verify`	Verify results against reference implementation.
`-t`	`--timing`	Print timing.
	`--dump`	Dump binary image for all devices.
	`--load`	Load binary image and execute on device.
	`--flags`	Specify compiler flags to build the kernel.
`-p`	`--platformId`	Select platformId to be used (o to N-1, where N is the number of available platforms).
`-v`	`--version`	AMD APP SDK version string.

Short Form	Long Form	Description
-W	--width	Width of the Mandelbrot image.
-H	--height	Height of the Mandelbrot image.
-x	--xpos	Xpos to generate the Mandelbrot fractal.
-y	--ypos	Ypos to generate the Mandelbrot fractal.
-xs	--xsize	Width of the window for the Mandelbrot fractal.
-i	--iterations	Number of iterations for kernel execution.
	--double	Enable double data type (default is float).
	--fma	Enable Fused Multiply-Add (FMA). The default is Multiply-Add.

2 Implementation Details

The Mandelbrot set is a set of points in the complex plane, the boundary of which forms a fractal. Reference [1] provides a detailed description of the Mandelbrot fractals and also provides the pseudo code to generate the Mandelbrot fractal.

The sample implements that pseudo code. The region of the complex plane is considered to be subdivided into a certain number of pixels. The algorithm consists of iterating through all the pixels. For each pixel, further iteration of a fixed number of steps is carried out to determine whether or not that pixel is in the Mandelbrot set.

The sample implementation parallelizes the computation such that each pixel is processed independently.

The following loop is run on each pixel of the fractal image being rendered.

```
{
  x0 = x co-ordinate of pixel
  y0 = y co-ordinate of pixel

  x = 0
  y = 0

  iteration = 0
  max_iteration = 1000

  while ( x*x + y*y <= (2*2)  AND  iteration < max_iteration )
  {
    xtemp = x*x - y*y + x0
    y = 2*x*y + y0

    x = xtemp

    iteration = iteration + 1
  }

  if ( iteration == max_iteration )
  then
    color = black
  else
    color = iteration

  plot(x0,y0,color)
}
```

3 References

1. http://en.wikipedia.org/wiki/Mandelbrot_set

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