

Range Minimum Query

1 Overview

1.1 Location `$<AMDAPPSDKSamplesInstallPath>\samples\opencl\cl\2.0`

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 executable is at

`$<AMDAPPSDKSamplesInstallPath>\samples\opencl\bin\x86\` for 32-bit builds, and
`$<AMDAPPSDKSamplesInstallPath>\samples\opencl\bin\x86_64\` for 64-bit builds. Ensure that the OpenCL 2.0 environment is installed.

Type the following command(s).

1. `RangeMinimumQuery`
This command runs the program with the default options.
2. `RangeMinimumQuery -h`
This command 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 meanings.
	--device [cpu gpu]	Devices on which the OpenCL kernel is to be run. Acceptable values are <code>cpu</code> or <code>gpu</code> .
-q	--quiet	Quiet mode. Suppresses all text output.
-e	--verify	Verify results against reference implementation.
-t	--timing	Print timing-related statistics.
-v	--version	AMD APP SDK version string.
	--dump [filename]	Dump the binary image for all devices.
	--load [filename]	Load the binary image and execute on the device.
	--flags [filename]	Specify the filename containing the compiler flags for building the kernel.
-i	--iterations	Number of iterations.
-p	--platformId	Select the platformId to be used[0 to N-1 where N is number platform s available].
-d	--deviceId	Select deviceId to be used[0 to N-1 where N is number devices available].

Short Form	Long Form	Description
-x	--numInputs	Array Length
-m	--startIndex	Start Index for RMQ <default value for m = 10>
-n	--endIndex	Last Index for RMQ <default value for n=99999999>
-l	--localsize	Number of work-items per work-group (should be 2^N)

2 Introduction

This sample demonstrates the ability in OpenCL 2.0 and higher versions to pass a pointer with an offset as a kernel argument. This was a restriction in OpenCL 1.2.

The sample uses `clSetKernelArgSVMPointer` to pass a Shared Virtual Memory (SVM) pointer with a specific offset as an argument value to kernel.

The sample also demonstrates another feature of OpenCL 2.0, which allows the NDRange to be flexible and a non-multiple of the workgroup size (unlike in OpenCL 1.2, in which NDRange needed to be a multiple of the workgroup size).

This sample also demonstrates how to use `work_group_reduce_<op>`, a work-group level built-in function in OpenCL 2.0.

3 Implementation

This sample implements the [Range Minimum Query \(RMQ\) problem](#).

3.1 RMQ Problem

Given an array $A[0 \dots n-1]$ of n objects, a range minimum query or RMQ asks for position of a minimum element in some sub-array $A[i \dots j]$.

For example:

Given $A = [6, 5, 2, 5, 4, 3, 1, 9, 3]$, then answer to RMQ for $A[3, 7] = [5, 4, 3, 1, 9]$ is 6, as $A[6] = 1$.

3.2 Implementation

The aim is to find minimum value in a given range/sub-set of the input values. The sample first creates a SVM buffer and populates the buffer with some random values. The SVM pointer along with the specified offset is passed as an argument value to *Range Minimum Query* kernel.

By default, the offset is set to 10, SVM pointer value specified as the argument value is (pointer+10), kernel launches ($n-1 - \text{offset} = n-11$) work-items, and returns minimum value within $A[10, n-1]$. User can also specify the range of sub-array within which minimum value has to be found. In this case, if user specifies some range, say for example $A[i, j] : 0 \leq i \leq j < n$, then SVM pointer value specified as the argument value would be (pointer+i), kernel would launch ($j + 1 - i$) work-items, and return minimum value within $A[i, j]$.

The sample uses `work_group_reduce_min`, a work-group level built-in function to find minimum value within a work-group.

4 References

1. <https://www.khronos.org/registry/cl/specs/opencl-2.0.pdf>
2. <https://www.khronos.org/registry/cl/specs/opencl-2.0-openccl.pdf>
3. http://wcipeg.com/wiki/Range_minimum_query

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