ATI STREAM COMPUTING SAMPLE

EigenValue

1 Overview

1.1 Location

`$(ATISTREAMSDKSAMPLESROOT)\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 `$(ATISTREAMSDKSAMPLESROOT)\samples\opencl\bin\x86\` for 32-bit builds, and `$(ATISTREAMSDKSAMPLESROOT)\samples\opencl\bin\x86_64\` for 64-bit builds.

Type the following command(s).

1. `EigenValue`
   Calculates the eigenvalues of a tridiagonal symmetric matrix of size 64x64.
2. `EigenValue -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.
`-v`	`--verbose`	Verbose output.
`-t`	`--timing`	Print timing.
`-x`	`--width`	Width of problem domain.
`-y`	`--height`	Height of problem domain.
`-z`	`--depth`	Depth of problem domain.
	`--device`	Devices on which the program is to be run. Acceptable values are cpu or gpu.

2 Introduction

The sample calculates the eigenvalues of a tridiagonal symmetric matrix of the form:

```
1 2 0 0
2 4 5 0
```

```
0 5 6 7
0 0 7 7
```

In this matrix, the diagonal elements are [1 4 6 7], and its length is the same as the size of the square matrix. The off-diagonal elements are [2 5 7], and its length is one less than the size of the square matrix.

3 Implementation Details

The input for the algorithm is a symmetric tridiagonal matrix. This also works for any symmetric real matrix because it can be reduced to a symmetric tridiagonal matrix, as explained in section 2.1 of reference [1]. In this document, the symmetric tridiagonal matrix is termed “matrix”; The eigenvalues of the matrix are called “eigenvalues.”

All the eigenvalues of the matrix lie in an interval, called the Gerschgorin interval. This is calculated using the method described in Figure 4.3 of reference [2]. This is the starting search space. The number of eigenvalues for any interval are calculated by using a method specified in FlCnt_IEEE, Algorithm-4, of reference [2]. This method calculates the number of eigenvalues that are less than a given floating point number. With this method, it is trivial to compute the number of eigenvalues for any interval.

The Gerschgorin interval is initially divided into as many equal intervals as there are eigenvalues. Each of these intervals is then recursively split into as many equal sub-intervals as there are eigenvalues in it. Intervals that do not have eigenvalues are discarded. If the interval has only one eigenvalue, it is bisected, and the half that does not have an eigenvalue is discarded. No bisection is done when the interval length is less than a given tolerance. Either the upper bound or lower bound of this interval can now be treated as an eigenvalue lying within acceptable tolerance.

4 References

1. I. S. Dhillon, A New O(N^2) Algorithm for the Symmetric Tridiagonal Eigenvalue/Eigenvector Problem, Ph.D. Thesis, University of California, Berkeley.
2. J. Demmel, I. Dhillon, and H. Ren, On The Correctness Of Some Bisection-Like Parallel Eigenvalue Algorithms In Floating Point Arithmetic, Trans. Num. Anal. (ETNA), 3, 1996.

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