Running GEANT4 Functions on a GPU

Discussion of Results

Stuart Douglas – dougls2
Rob Gorrie – gorrierw
Matthew Pagnan – pagnanmm
Victor Reginato – reginavp

McMaster University

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Overview

Brief Project Overview

Take an existing particle simulation toolkit - GEANT4 - and have some functions run on a GPU device to improve performance.

Definition: GEANT4

GEANT4 is

Stakeholders

What is GEANT4

- Geant4 is a toolkit that is meant to simulate the passage of particles through matter.
- It has been developed over the years through collaborative effort of many different institutions and individuals.
- Geant4 has many different applications, including applications in high energy physics, space and radiation, medical.

What is GP-GPU

- General purpose graphic processing unit computing is a re-purposing of graphics hardware
- Allows GPUs to perform computations that would typically be computed on the CPU
- If problems are suitable to mass parallelization

Scope

Purpose

Why G4ParticleHPVector

Two Implementations

- Run everything on the GPU
- Only select functions run on GPU

Completely on GPU

- The vector is stored exclusively on the GPU
+ Do not have to maintain a copy of the vector on the CPU
+ Do not have to maintain the hashed vector
+ Reduces how much is being copied to the GPU
– All functions are run on the GPU

Intensive Functions on GPU

Performance Results

Performance Discussion

Accuracy

Testing

Implementation 2

+ Only functions that run faster on the GPU are implemented
+ Not forced to run functions that run slowly on GPU
– Will have to maintain two copies of the vector
– More copying the vector to and from the GPU

Performance Summary

- Most functions slower on GPU until ~10,000 entries
- Most *commonly-used* functions significantly slower on GPU
  - Lots of data accesses
- Many problems in vector class not well-suited to parallelism

Performance Results - `Times`

- Multiplies each point in vector by factor

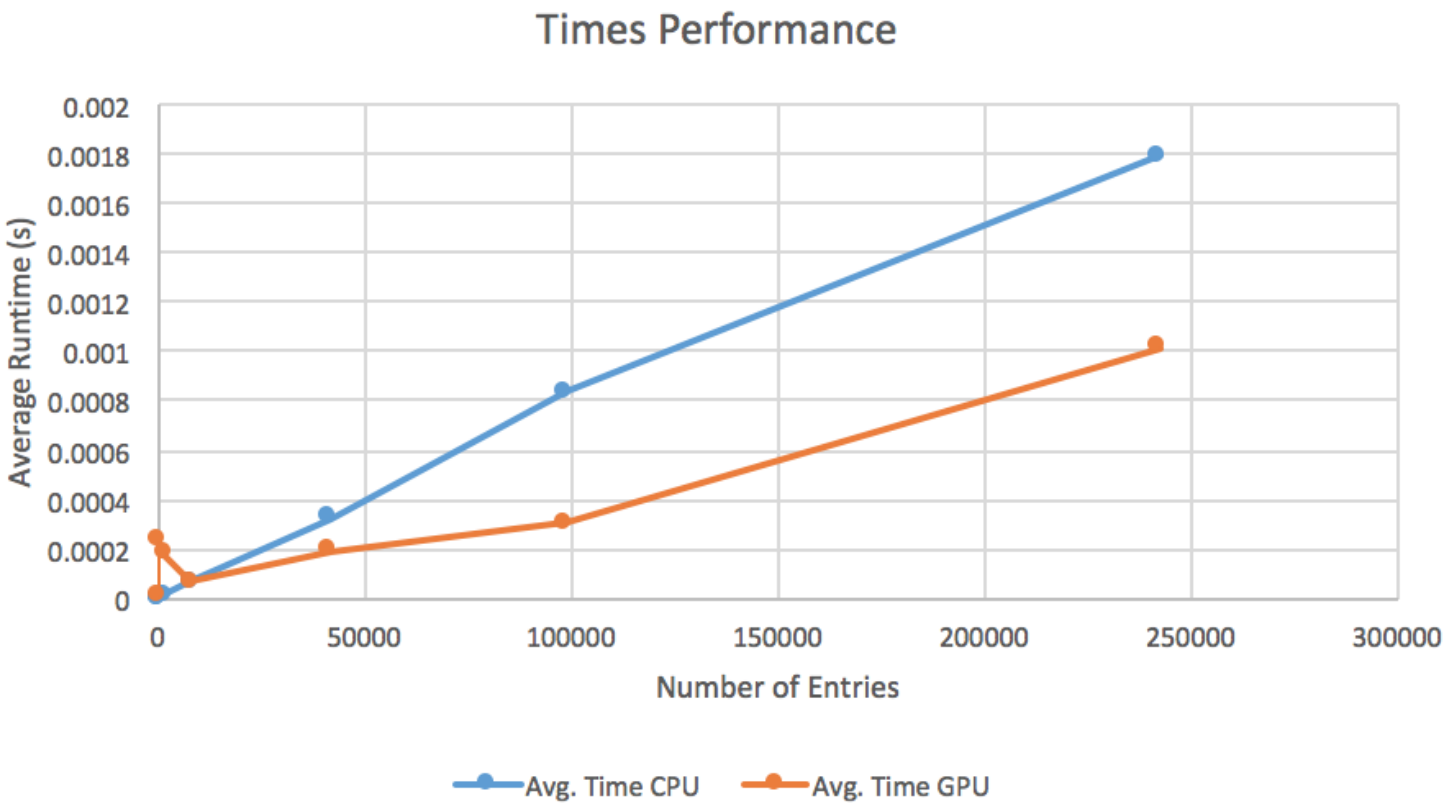

Figure : Runtime vs. Number of Data Points – `Times`

Performance Discussion

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Testing

Summary of Results

Recommendations