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COMPARISON BETWEEN THE PERFORMANCES OF GAUSS SEIDEL ALGORITHM AND JACOBI ALGORITHM ON GPU TO SOLVE THE EIGEN VALUES OF SYMMETRIC MATRICES

Teja U. Naik

Department of Electronics and Telecommunication, Goa University
Goa College of Engineering ,Ponda Farmagudi ,Goa (India)

ABSTRACT

Modern GPUs can be used for general purpose computing using dedicated libraries such as CUDA (for NVIDIA cards) or OpenCL. GPUs are more efficient than CPUs due to their highly parallel structure and therefore the performance of GPU is faster than CPU.The Jacobi and Gauss Seidel algorithms are iterative algorithms which solves the n number of linear equation of the form AX=b. The Gauss Seidel algorithm is the modification of Jacobi algorithm.In this project I created API functions for Gauss Seidel algorithm on GPU and then the performance is compared with the Jacobi algorithm. It is found that the performance of Gauss Seidel algorithm is faster than the Jacobi algorithm.

Keywords –CPU,GPU, Gauss Seidel algorithm, Jacobi algorithm, Symmetric matrices

I. INTRODUCTION

The Gauss Seidel algorithm is the modification of Jacobi algorithm.The Jacobi algorithm uses only results from the previous iteration, whereas the Gauss–Seidel scheme uses results from this iteration as the results are ready. There are many methods to solve the Eigenvalues of the matrices. Some of the algorithms are Gauss Elimination, Gauss Jordon ,Jacobi algorithm etc. Through iterative methods an approximate solution is obtained within the error tolerance.

The eigenvalues of matrices helps to solve variety of math problems. A linear equation of the form AX=b where A is an n by n dense matrix, b is a known n-vector and x is n-vector to be determined is used to find the solution of the system of linear equations. In general Jacobi method and Gauss Seidel algorithm both converge ,but the Gauss Seidel algorithm converges faster than the Jacobi algorithm.

GPUs are faster than CPUs(Central Processing Unit) because of their highly parallel structure and is also famous for their programming capabilities for performing faster calculations. The GPUs were originally used for 3D game rendering . CUDA (Complete Unified Device Architecture) is a programming technology proposed by

NVIDIA which gives new idea and provides a way to solve the large eigenvalues matrices. Nowadays people use CUDA not only for graphics and images but also to perform numerical calculations. As compared to GPUs , CPUs are composed of few cores . GPUs are composed of thousands of cores that can handle thousands of threads simultaneously .GPUs are parallel architectures that perform multiple tasks simultaneously

II. CUDA OVERVIEW

GPU has many advantages over cpu in memory bandwidth and processing ability. Power consumed by GPU is less compared to the CPU. GPU is considered to be 10 times faster than the CPU. In November 2006, NVIDIA introduced CUDA, a general purpose parallel computing platform and programming model that leverages the parallel compute engine in NVIDIA GPUs to solve many complex computational problems in a more efficient way than on CPUs[2]. CUDA software is used as a highlevel programming language that is the c language. Other languages which could be used are, FORTRAN, DirectCompute, OpenACC. The program codes are divided into two ,host code and device code which runs on CPU and GPU respectively. CUDA C extends C by allowing the programmer to define C functions, called kernels, that, when called, are executed N times in parallel by N different CUDA threads, as opposed to only once like regular C functions[2]. A kernel is a function executed on the GPU as an array of threads in parallel[3]. The CUDA thread structure is shown in Figure 1. Threads of an executing kernel are organized as blocks, and blocks are organized as grids. A block is the execution unit of a kernel. A grid is a collection of blocks which can be executed in parallel. All blocks are executed in parallel. There is no communication and execution order among blocks. Within a block, all threads are executed in parallel. The same kernel program can be executed in parallel by all the threads of the blocks which are contained in the same grid. Threads in the same block communicate with each other by using the shared memory and are synchronized by using the syncthreads() function. This is the two-level block-thread parallel execution model of CUDA[1].

Cuda application has access to different types of memory. While designing the algorithm there are tradeoffs that must be considered for different memory type. These different types of memory each have different properties such as access latency, address space, scope, and lifetime. The different types of memory are register, shared, local, global, and constant memory. Each block has a shared memory, which can be read and written by the threads in the same block. The global memory can be accessed by all the threads in the same grid[1].

III. PERFORMANCE OF GAUSS SEIDEL ALGORITHM AND JACOBI ALGORITHM ON GPU

The Jacobi Algorithm is implemented on the GPU.The size of matrices used are 50x50, 200x200, 700x700, 1000x1000 ,2000x2000 and 5000x5000.As the size of matrices increases the running time also increases.

The resulting graph is shown in fig 1.The Gauss Seidel algorithm is also implemented on GPU for the same size of matrices,the graph is shown in fig 2.It is observed that as the size of matrices increases the running time of these matrices increases and also it is observed that the performance of Gauss Seidel algorithm is faster than the Jacobi algorithm.

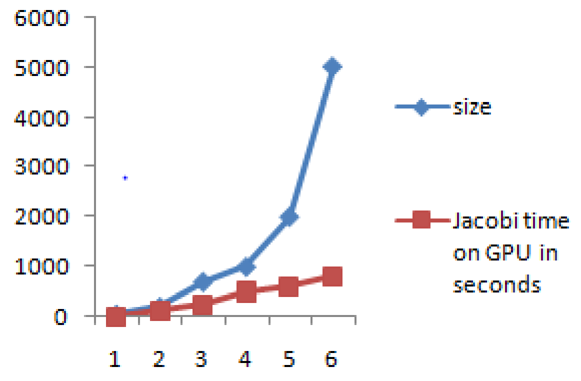

Fig. 1 Jacobi time vs size

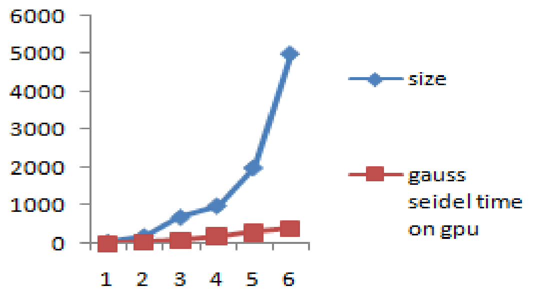

Fig. 2 Gauss Seidel time vs size

IV. CONCLUSIONS

The Jacobi and Gauss Seidel algorithms are iterative algorithms which solves the n number of linear equation of the form AX=b. The Gauss Seidel algorithm is the modification of Jacobi algorithm.In this project I created API functions for Gauss Seidel algorithm on GPU and then the performance is compared with the Jacobi algorithm. It is found that the performance of Gauss Seidel algorithm is faster than the Jacobi algorithm

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