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A PAPER SURVEY ON THE IMPLEMENTATION OF THE PARALLEL FDTD ON MULTIPROCESSORS USING MPI

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ABSTRACT

The research work explains a cost-effective, high-performance computing platform for the parallel implementation of the FDTD algorithm on PC clusters using the message-passing interface (MPI) library, which is a local area network system consisting of multiple interconnected personal computers (PCs), and is already widely employed for parallel computing.

1. INTRODUCTION

The Finite-difference time-domain is a numerical analysis technique used for modeling computational electrodynamics (finding approximate solutions to the associated system of differential equations). Finite- difference time domain (FDTD) solves the electromagnetic wave equation in the time domain using finite-difference approximations and is today one of the most popular technique for the solution of electromagnetic problems [5].

1.1 PURPOSE OF STUDY

1. Performing tasks on remote computers for distributed jobs to take advantage of multi-core workstations (FDTD, varFDTD solvers) to overcome the restriction size of multiple cores in order to have an implementation with good efficiency characteristics and low execution time.
2. To understand FDTD mathematically, as well as some basic FDTD algorithm, because it seems to have a high and efficient parallelization.
3. To implement parallelizing in order to reduce memory use and improve the time for execution . The 6 partial differential equations of the FDTD numerical algorithm

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1.2 APPLICATION AND USES OF FDTD

- In electromagnetic simulation in radar cross-section calculations
- Used in microwave ovens
- Antenna design analysis
- Electromagnetic compatibility analysis
- Medical research such as breast cancer detection
- Computer chips and circuit design
- Physics-based signal processing and imaging

2. LITERATURE REVIEW

2.1 PARALLEL FDTD

Generally Multiprocessors can be either: Shared memory, Distributed memory or Distributed-shared memory.We need to parallelize FDTD to satisfy features like load balance, memory usage balance, minimize communication overhead, and reduce sequential bottlenecks and scalability [3].

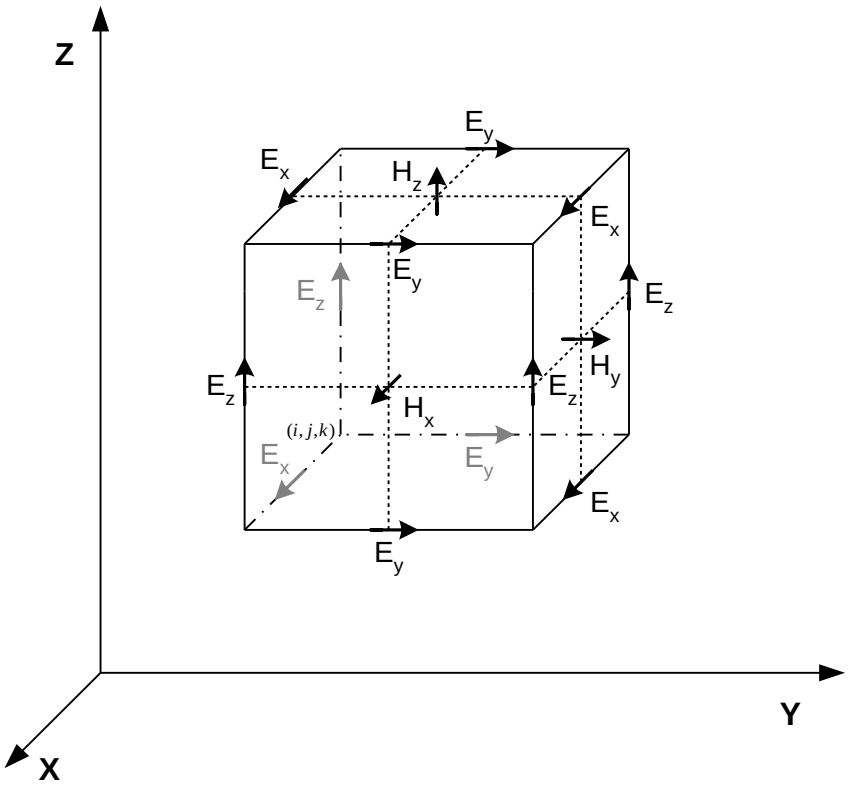

Figure 1: The Yee Cell [4].

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3. METHODOLOGY

Thus, a large number of memory and computational time will be consumed when big dimension and complex structure object is considered, which is beyond the capability of single computer [12]. The research computation of this study is based on FDTD and MPI, using C and its correctness will be tested by comparing different results respectively [14].

3.1 PARALLEL PROGRAMMING

In simple terms it's a type of computation that allows various calculations or execution of tasks simultaneously[15]. Parallel program consists of multi-tasks running on multiple processors waiting to be compiled or set of instructions executed by a processor [10]. Taking current observations of weather and processing these data with computer models to forecast the future state of weather [9]. Used to study wealth of ocean using multiprocessors having large computational power with low power requirements. Parallel processing is used for modeling of economy of a nation/world. High interaction between processors along with Shared memory modules can communicate calculations to distribute them across as many processors as you can get simulations to complete faster, improve accuracy, or simulate bigger physical systems [1] [8].

2.2 PARALLEL PROGRAMMING TECHNIQUES GPU

They include MPI which is explained throughout these piece of paper, VALU vector arithmetic logic unit, AVX advanced vector extensions, CUDA compute unified device arch, PVM parallel virtual machines and NUMA non-uniform memory access. [11].

3.2.1 GPU

Used primarily for 3-D applications. It is a single-chip processor that creates lighting effects and transforms objects every time a 3D scene is redrawn. These are mathematically-intensive tasks, which otherwise, would put quite a strain on the CPU. Lifting this burden from the CPU frees up Cycles that can be used for other tasks[11].

3.2.2 CUDA

CUDA is a parallel computing platform and programming model invented by NVIDIA [13]. It enables dramatic increases in computing performance by harnessing the power of the graphics processing unit (GPU) [6].

3.2.3. PVM

Is a software package that permits heterogeneous collection of Unix and/or Windows computers hooked together by a network to be used as a single large parallel computer. [7]. [10]

4. DISCUSSION OF RESULTS AND COMPARISONS

The study uses MPI to develop a widely used standard for writing message passing programs. The interface establishes a practical, portable, efficient and flexible standard, specifies a library in a language in-dependent form and provides a bind between C and FORTRAN. It has gained wide acceptance in parallel computing ranging from Massively Parallel systems to network of computers and workstations [1]. [2].

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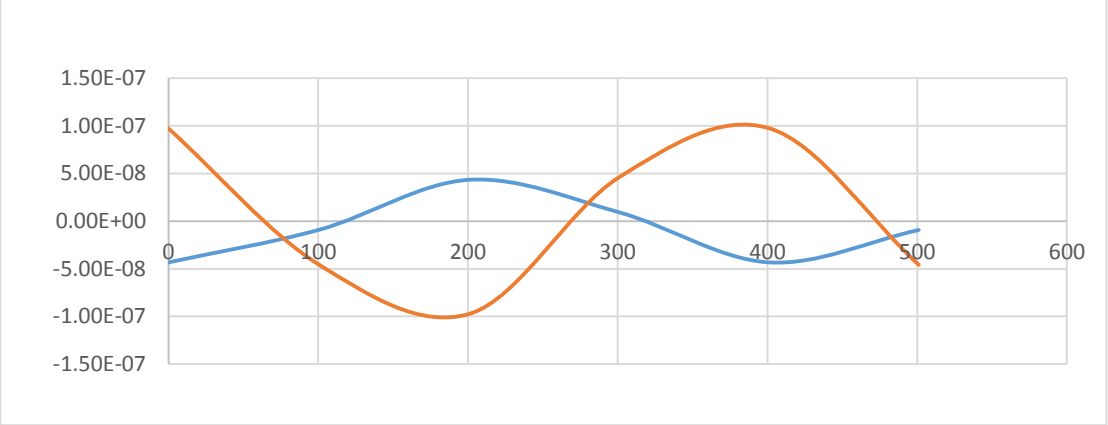

Figure 2: the comparison results between execution single computer and multiple computers.

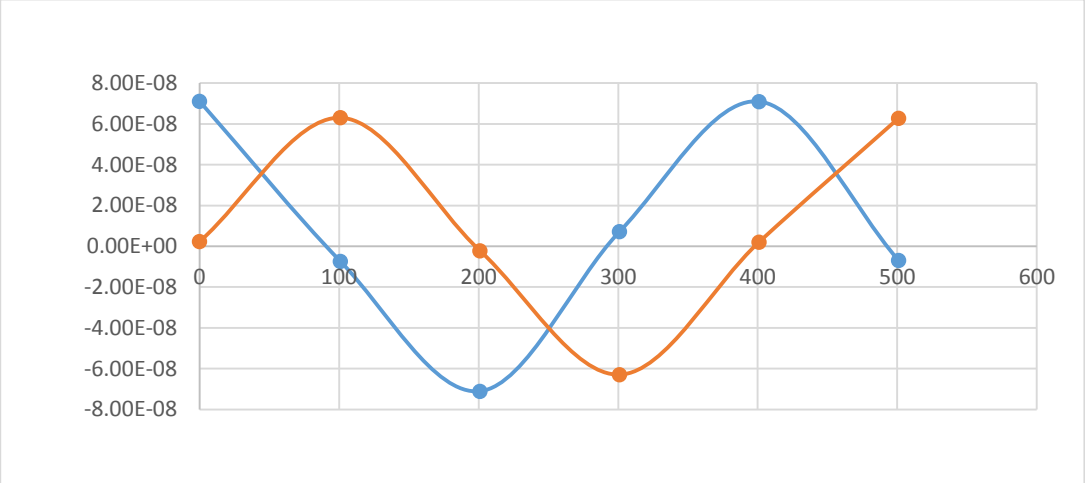

Figure 3: the compilation and memory usage of single computer and multiple computers.

Table 1: Comparison table on the methods

SCHEME	ΔT	TOTAL TIME	CPU TIME (Secs)	MEMORY (MB)
FDTD	**$25*10^{-12}$**	5	19	2.06
		10	24	16.5
		15	35	4.0

4.1 SUMMARY

The proposed system depends on progressively applying forward and differencing in time for the conduction of execution and compilations, the is more effective for substantial Courant numbers. This work presents another structure that allows less machine memory storage, and more importantly CPU time, for instance in the computational area is much smaller than the wavelength of the methods. Numerical simulation observations demonstrates that the new technique is extremely proficient, and the results are exceptionally well with FDTD method as explained more in the table.

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5. RECOMMENDATIONS

The (FDTD) system for settling the full-wave Maxwell's comparisons has been as of late stretched out to give exact and numerically steady operation for time steps surpassing each other as far as possible. One such class of issues is the investigation of fast execution time which interconnects the techniques that are frequently required for the exact determination of a typical electromagnetic wave phenomena.

6. CONCLUSION

It has been observed that the parallel implementation of the proposed algorithm provides a significant reduction in simulation time needed to update field components as well as the communication time needed to perform the interprocessor communication, when partitioning the computational domain over many processors, especially for small domains, the efficiency of the parallelization will reach a limitation due to increase in the communication time between the processors.

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