GOVERNMENT COLLEGE UNIVERSITY, LAHORE

DEPARTMENT OF COMPUTER SCIENCE

Report: Quick Sort Parallel Algorithm

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Parallel Performance of MPI Quick Sort Algorithm

1 ABSTRACT

Message Passing Interface (**MPI**) is widely used to implement parallel programs. Although Windows based architectures provide the facilities of parallel execution and multi-threading, little attention has been focused on using MPI on Linux platforms. In this report I use the core i7 Ubuntu-based platform to study the effect of parallel processes on the performance of MPI parallel implementations for Quick sort algorithm.

2 KEYWORDS

Parallel programming, Message Passing Interface, performance

3 INTRODUCTION

QuickSort is a Divide and Conquer Algorithm. It picks an element as a pivot and partitions the array around the picked pivot. There are many ways of choosing the pivot elements. They are:

- Always pick the first element as a pivot.
- Always pick the last element as the pivot (implemented below)
- Pick a random element as a pivot.
- Pick median as a pivot.

MPI: MPI stands for Message Passing Interface. Here the message is data. MPI allows data to be passed between processes in a distributed memory environment. In C, “mpi.h” is a header file that includes all data structures, routines, and constants of MPI. Using “mpi.h” parallelized the quick sort algorithm. Below is the C program to implement quicksort using MPI:

```
/* Quick Sort */
// (quick) sort slice of array v; slice starts at s and is of length n
1. quicksort(sub-list v, start, length)
2.{
3. int pivot, pstart, i;
4. if (length <= 1)
5. return;
// pick pivot and swap with first element
6. pivot = sub-list[start + length/2];
7. swap(sub-list[], start, s + length/2);
// partition slice starting at s+1
8. pstart = start;
9. for (i = start+1; i < start+length; i++)
10. if (sub-list[i] < pivot)
11. { pstart++;
12. swap(sub-list[], i, pstart);
13. }
// swap pivot into place
14. swap(sub-list[], start, pstart);
// recurse into partition
15. quicksort(sub-list[], start, pstart-start);
16. quicksort(sub-list[], pstart+1, start+length-pstart-1);
17.}
```

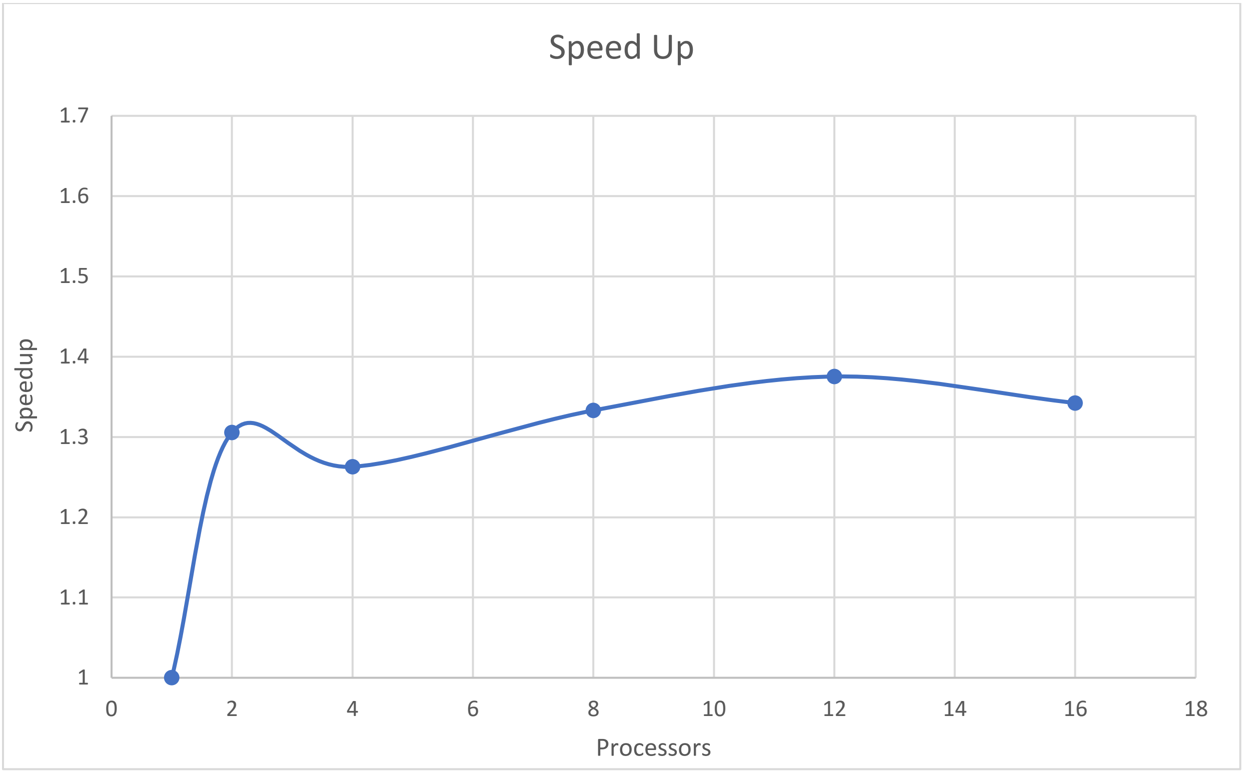
3.1.1 The MPI code for Quick Sort is here on my Github

https://github.com/MuhammadZeeshanYousaf/Parallel-Programming-MPI/tree/main/Project

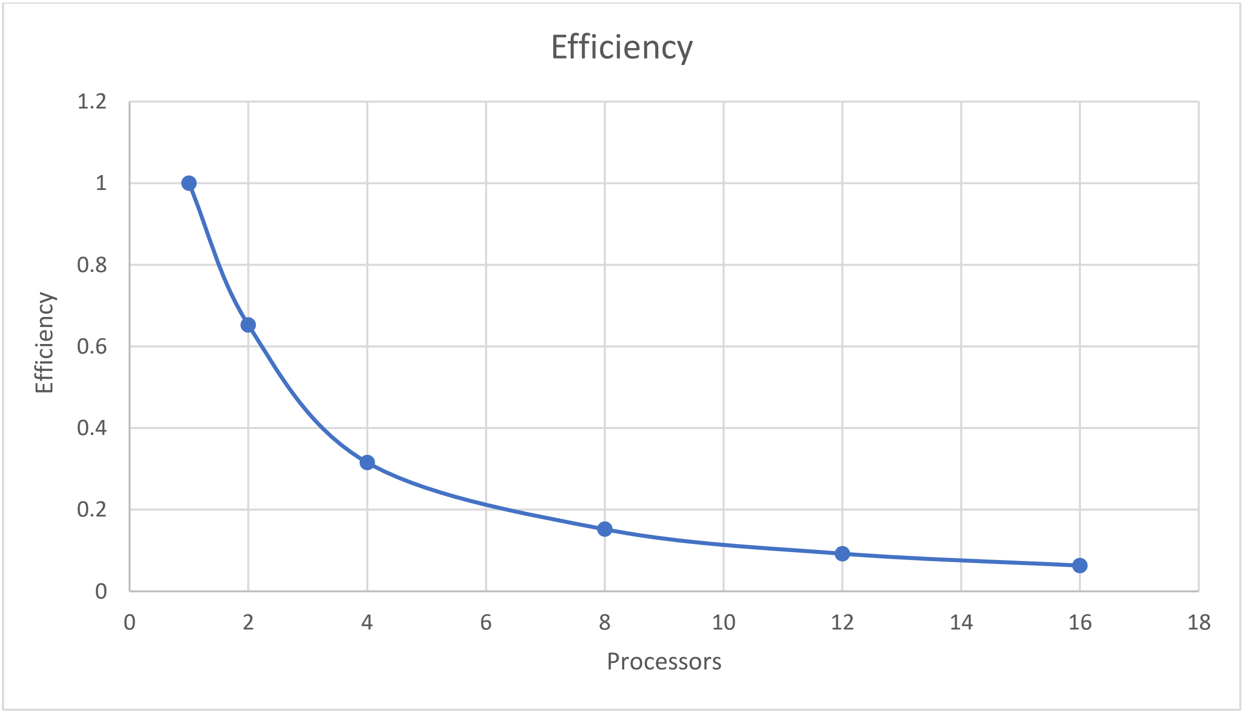
4 RESULT OF EXPERIMENTS

No. of Processors (P)	**Data (Integers to sort)**	**Execution time (sec)**	**Speed up (Ts / Tp)**	**Efficiency (S / P)**
1	13000	4.203	1	1
2	13000	3.219	1.3056	0.6528
4	13000	3.328	1.2629	0.3157
8	13000	3.153	1.3330	0.1666
12	13000	3.056	1.3753	0.1146
16	13000	3.131	1.3423	0.0838

5 Speed up Graph



6 Efficiency Graph



7 CONCLUSION

In this report I focused on using MPICH as a message passing interface implementation on Ubuntu platforms. The effect of parallel processes number and also the number of cores on the performance of parallel quick sort algorithms has been experimentally studied.
I found that the computation / communication ratio greatly affects the execution time of the three studied parallel algorithms.