Report for HPC LAB

Name: Bhaskar R
Roll No: CED18I009
Programming Environment: MPI
Problem: Vector Dot Product
Date: 30th October 2021

Hardware Configuration:

CPU NAME : Intel core i5 – 8250U @ 1.60 GHz
Number of Sockets : 1
Cores per Socket : 4
Threads per core : 2
L1 Cache size : 32KB (Per Core)
L2 Cache size : 256KB (Per Core)
L3 Cache size : 6MB (Shared)
RAM : 8 GB

Serial Code:

```
#include <mpi.h>
#include <stdio.h>
#include <stdlib.h>
#include <math.h>
#define N 100
int main()
{
	double start, end;
	start = MPI_Wtime();
	float arr1[N], arr2[N], result = 0.0;
	for (int i = 0; i < N; i++)
	{
		arr1[i] = i + 1.0;
		arr2[i] = i + 1.0;
	}
	for (int i = 0; i < N; i++)
	{
		result += (arr1[i] * arr2[i]);
	}
	printf("Sum is %f.\n", result);
	end = MPI_Wtime();
	printf("\nTime= %f", end - start);
}
```

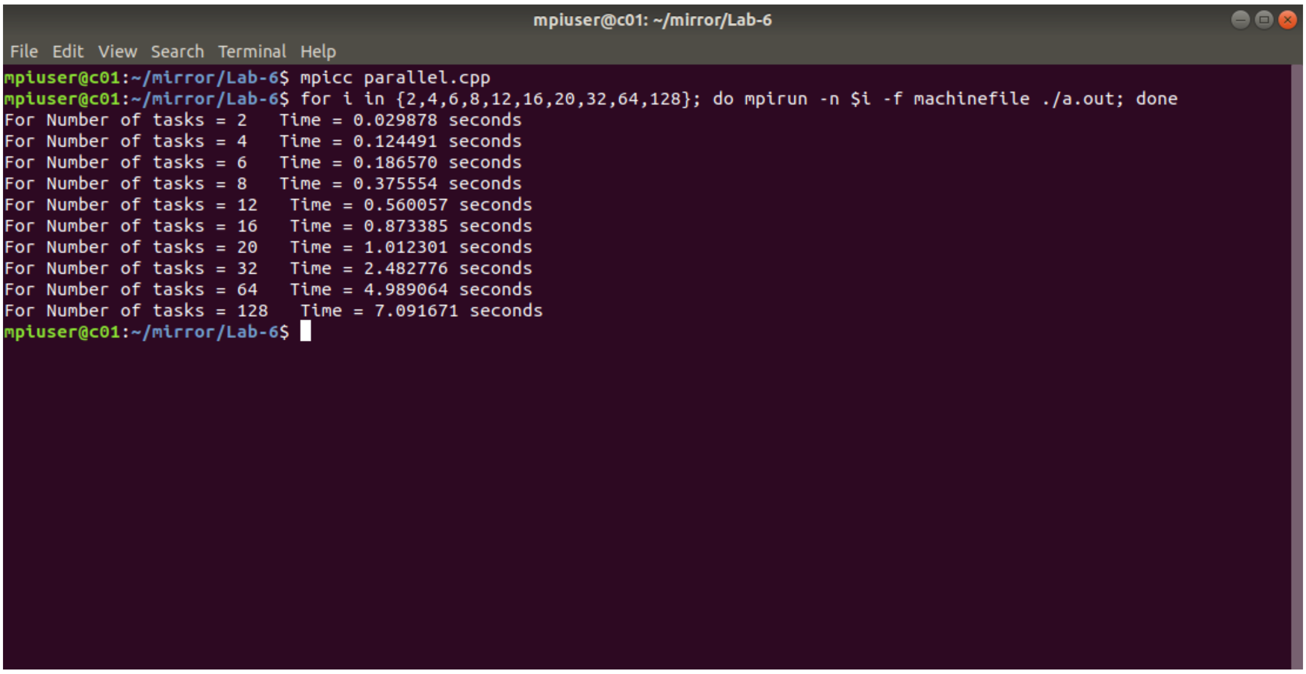
Parallel Code :

```
#include <mpi.h>
#include <stdio.h>
#include <stdlib.h>
#include <math.h>
#define N 100

int main(int argc, char **argv)
{
	int myid, numprocs;
	int i, x, start, end, rem;
	long double val = 0, result, arr1[N], arr2[N];
	double st, ed;
	MPI_Init(&argc, &argv);
	MPI_Comm_size(MPI_COMM_WORLD, &numprocs);
	MPI_Comm_rank(MPI_COMM_WORLD, &myid);
	char pro_name[MPI_MAX_PROCESSOR_NAME];
	int name_len;
	MPI_Get_processor_name(pro_name, &name_len);
	if (0 == myid)
	{
		st = MPI_Wtime();
		for (i = 0; i < N; i++)
		{
			arr1[i] = i;
			arr2[i] = i;
		}
	}
	/* broadcast arr */
	MPI_Bcast(arr1, N, MPI_LONG_DOUBLE, 0, MPI_COMM_WORLD);
	MPI_Bcast(arr2, N, MPI_LONG_DOUBLE, 0, MPI_COMM_WORLD);
	/* add portion of arr */
	x = N / numprocs;
	start = myid * x;
	end = start + x;
	for (i = start; i < end; i++)
	{
		val += (arr1[i] * arr2[i]);
	}
	printf("Calculated %Lf in %d - %s\n", val, myid, pro_name);
	/* compute global sum */
	MPI_Reduce(&val, &result, 1, MPI_LONG_DOUBLE, MPI_SUM, 0,
MPI_COMM_WORLD);
	if (0 == myid)
	{
		rem = N % numprocs;
		for (i = N - rem; i < N; i++)
			result += (arr1[i] * arr2[i]);
		printf("Dot product is %Lf.\n", result);
		ed = MPI_Wtime();
```

```
            printf("\nTime= %f", ed - st);
        }
        MPI_Finalize();
}
```

Output :



Compilation and Execution:

Compiling using mpic++ parallel.cpp

For execution use

for i in {2,4,6,8,12,16,20,32,64,128}; do mpirun -n $i -f machinefile ./a.out

Observations:

Number of Threads	Execution Time	Speed-up	Parallelization Fraction
1	0.01	1.0	
2	0.02	0.5	-2.0
4	0.12	0.0833	-14.6731
6	0.18	0.0556	-20.3827
8	0.37	0.027	-41.1852
12	0.56	0.0179	-59.8537
16	0.87	0.0115	-91.687
20	1.01	0.0099	-105.2738
32	2.48	0.004	-257.0323
64	4.98	0.002	-506.9206
128	7.09	0.0014	-718.9021

Speed up can be found using the following formula,

S(n)=T(1)/T(n)

where, S(n) = Speedup for thread count 'n'

T(1) = Execution Time for Thread count '1' (serial code)

T(n) = Execution Time for Thread count 'n' (serial code)

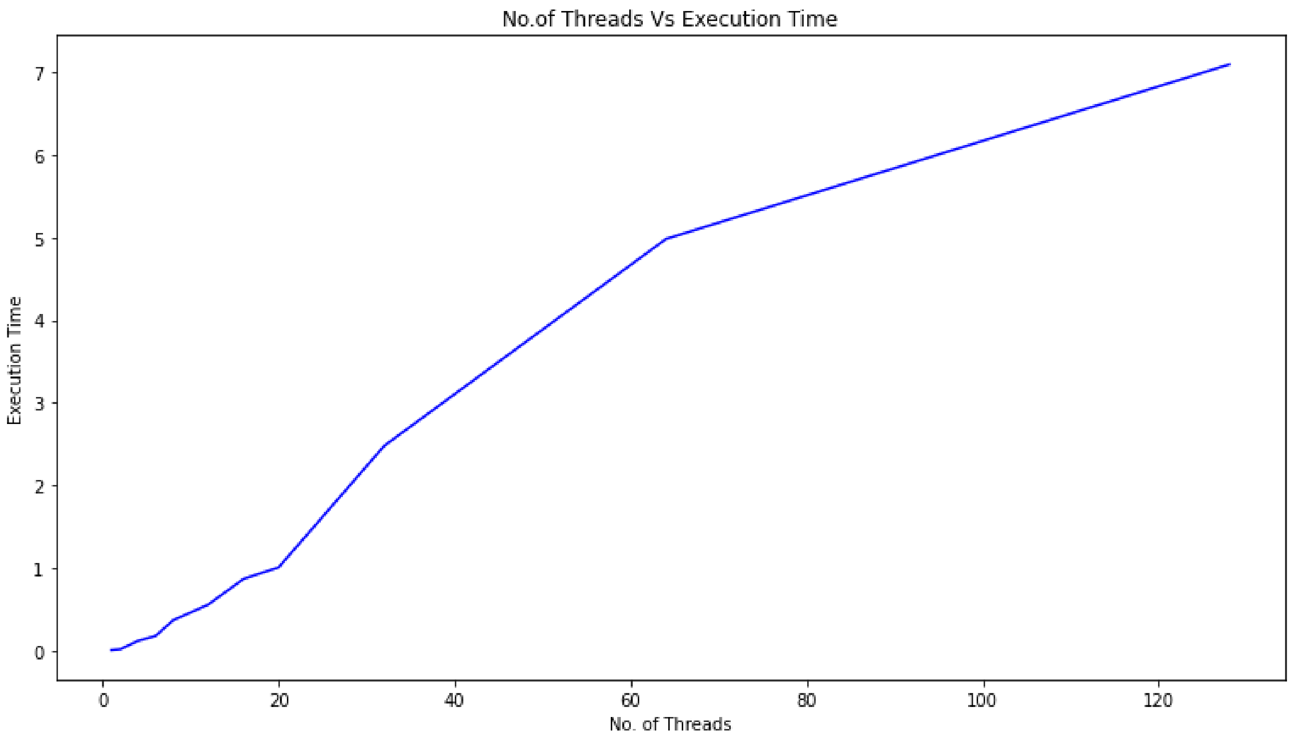
Parallelization Fraction can be found using the following formula, **S(n)=1/((1 - p) + p/n)**

where, S(n) = Speedup for thread count 'n'

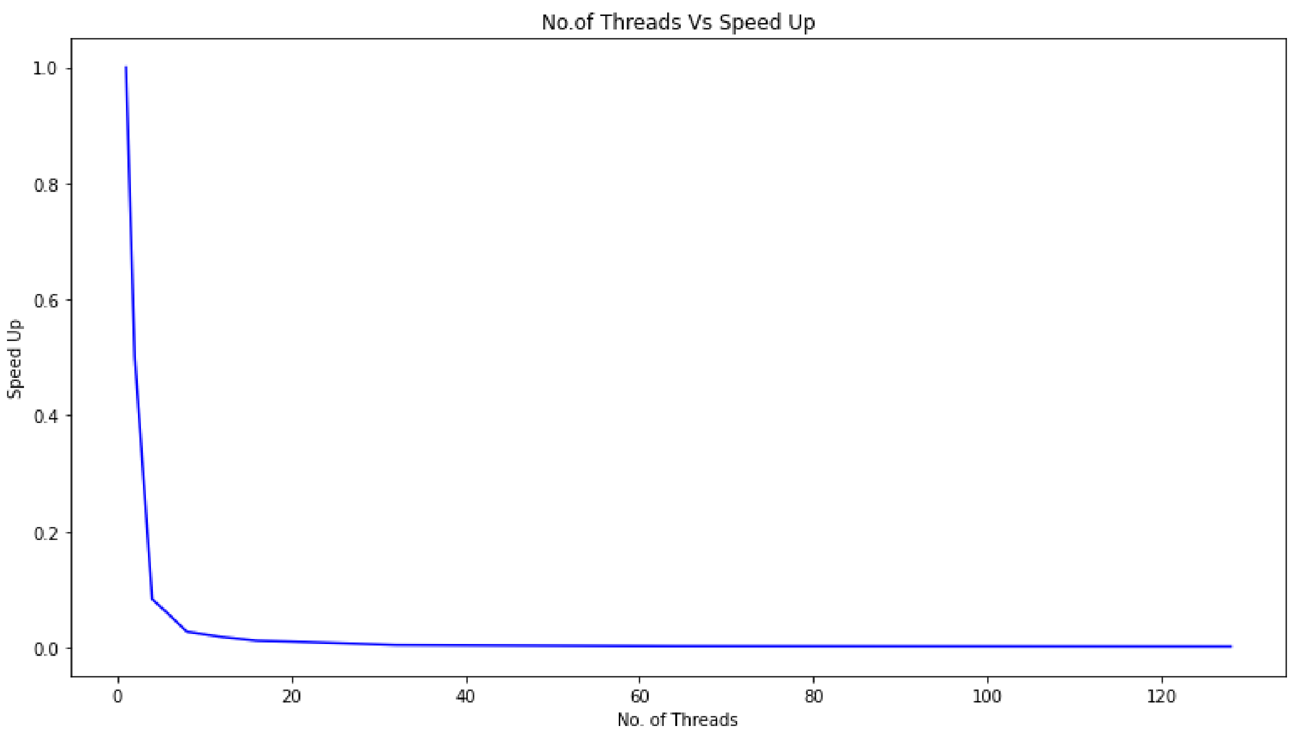
n = Number of threads

p = Parallelization fraction

Number of Threads vs Execution Time:



Number of Threads vs Speed Up:



Inference:

•Execution time is increasing with an increase in the number of threads.
Since the problem is of smaller complexity the overheads of parallelization seem to have more effects here.