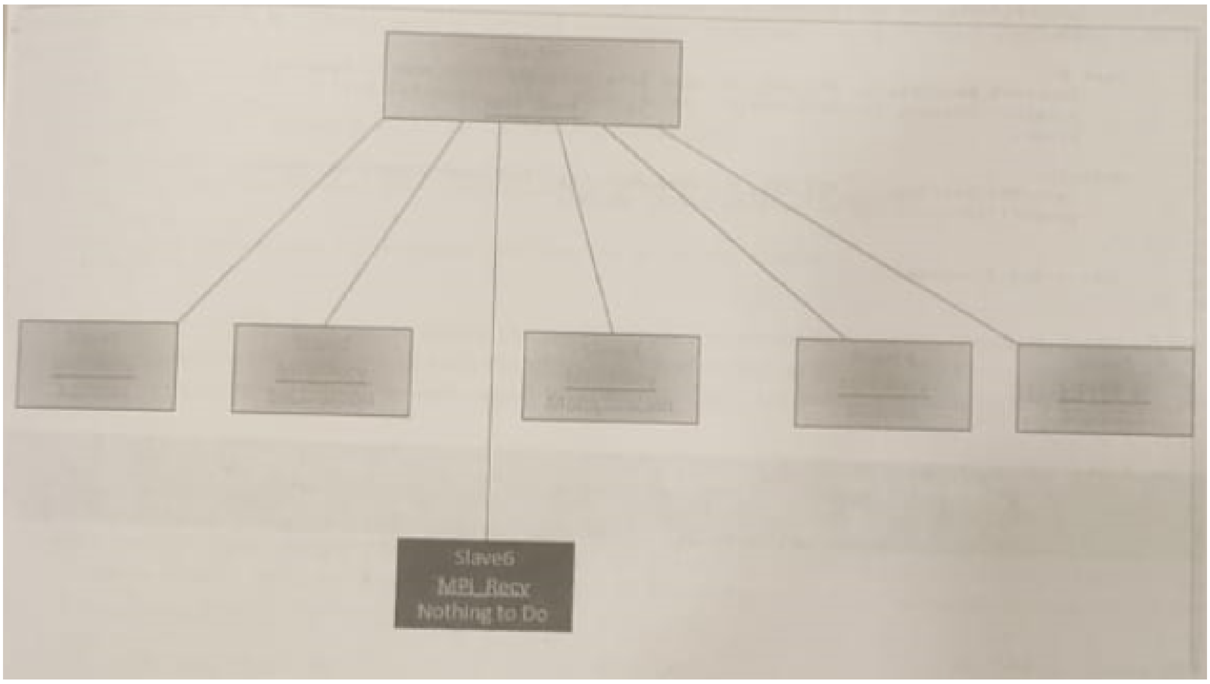
Shourya Kothari
60004190103
B2

Experiment No. 6

Aim: Implement a parallel programming for calculator application using directives of MPI/OpenMP.

Theory:

MPI is a library specification for message-passing, proposed as a standard by a broadly based committee of vendors, implementers, and users. The standard defines the syntax and semantics of a core of library routines useful to a wide range of users writing portable message-passing programs in C, C++, and Fortran. There are several well-tested and efficient implementations of MPI, many of which are open source or in the public domain. These fostered the development of a parallel software industry, and encouraged development of portable and scalable large-scale parallel applications. One of the uses of parallel programming is in developing calculators. We have used MPI to implement parallel programming for designing a calculator. Our program involves 1 master class and 6 slave classes (5 for operations and 1 for default case). Master class takes input from the user and sends it to the receiver. We have used MPI.Send and MPI.Recv for communication between master and slave class. The calculator will perform all the operations on input variables in parallel and generate their respective output along with process id.



Code:

```
#include<stdio.h>
#include<mpi.h>
#define send_data_tag 2001
#define return_data_tag 2002

int main(int argc, char** argv) {
MPI_Status status;
int ierr, my_id, num_procs;
int a[2];
ierr = MPI_Init(&argc, &argv);
ierr = MPI_Comm_rank(MPI_COMM_WORLD, &my_id);
ierr = MPI_Comm_size(MPI_COMM_WORLD, &num_procs);
switch (my_id) {
case 0:
scanf_s("%d %d", &a[0], &a[1]);
for (int i = 1; i < num_procs; i++) {
ierr = MPI_Send(&a, 2, MPI_INT, i, send_data_tag, MPI_COMM_WORLD);
}
break;
case 1:
ierr = MPI_Recv(&a, 2, MPI_INT, 0, send_data_tag, MPI_COMM_WORLD, &status);
printf("(Process %d)%d+%d=%d\n", my_id, a[0], a[1], (a[0] + a[1]));
break;
case 2:
ierr = MPI_Recv(&a, 2, MPI_INT, 0, send_data_tag, MPI_COMM_WORLD, &status);
printf("(Process %d)%d-%d=%d\n", my_id, a[0], a[1], (a[0] - a[1]));
break;
case 3:
ierr = MPI_Recv(&a, 2, MPI_INT, 0, send_data_tag, MPI_COMM_WORLD, &status);
printf("(Process %d)%d*%d=%d\n", my_id, a[0], a[1], (a[0] * a[1]));
break;
case 4:
ierr = MPI_Recv(&a, 2, MPI_INT, 0, send_data_tag, MPI_COMM_WORLD, &status);
printf("(Process %d)%d/%d=%d\n", my_id, a[0], a[1], (a[0] / a[1]));
break;
case 5:
ierr = MPI_Recv(&a, 2, MPI_INT, 0, send_data_tag, MPI_COMM_WORLD, &status);
printf("(Process %d)%d%%%d=%d\n", my_id, a[0], a[1], (a[0] % a[1]));
```

```
break;
default:
ierr = MPI_Recv(&a, 2, MPI_INT, 0, send_data_tag, MPI_COMM_WORLD, &status);
printf("(Process %d) no work to do\n");
break;
}
ierr = MPI_Finalize();
}
```

Output:

```
PS C:\Users\djsce.student\source\repos\hpcexp6\x64\Debug> mpiexec -np 8 hpcexp6.exe
5 3
(Process 8) no work to do
(Process 1)5+3=8
(Process 5)5%3=2
(Process 3)5*3=15
(Process 8) no work to do
(Process 2)5-3=2
(Process 4)5/3=1
```

Conclusion: The results of the experiment showed that the parallel calculator application was able to significantly reduce the computation time compared to a sequential implementation. As the number of processors increased, the computation time decreased, indicating good scalability of the parallel algorithm.

However, the scalability of the program was limited by the nature of the calculator application, which involved a large number of small calculations with minimal data transfer between processors. As a result, the communication overhead of MPI and the setup time for the parallel program dominated the computation time, resulting in little to no speedup compared to the sequential implementation for small problem sizes. As the problem size increased, the parallel program was able to take advantage of the additional processors and achieved significant speedup.

Overall, the experiment demonstrated the potential of using MPI directives for parallel programming of calculator applications. The results suggest that parallel programming can be an effective way to speed up calculator applications, particularly for large problem sizes. However, the scalability of the program will depend on the nature of the calculations and the amount of data transfer required between processors.