PARALLEL AND DISTRIBUTED COMPUTING LAB

REPORT

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REG NO: 19BCE1560

PROGRAMMING ENVIRONMENT: MPI

PROBLEM: MPI

DATE: 17th November, 2021

HARDWARE CONFIGURATION:

CPU NAME	:	Intel core i5 – 1035G1 @ 1.00 Ghz
Number of Sockets:	:	1
Cores per Socket	:	4
Threads per core	:	1
L1 Cache size	:	320KB
L2 Cache size	:	2MB
L3 Cache size (Shared):		6MB
RAM	:	8 GB

QUESTION

Write an MPI program that reads the RGB matrices of an image and find the average of these three, thereby converting the image to a grayscale version.

CODE

avg.c

```
#include <mpi.h>
#include <stdio.h>
#include <stdlib.h>
#include <time.h>

const int n = 479; //height of image
const int m = 500; //width of image

void readMatrix(int matrix[n][m],int color)
{
   FILE *fp;
   if(color==0) //0: red, 1: green, anything else: blue
   fp = fopen("r.txt", "r");
   else if(color==1)
   fp = fopen("g.txt", "r");
```

```
    else
    fp = fopen("b.txt", "r");

    int r=0,c=0;
    int x;

    while((fscanf(fp,"%d,",&x)!=EOF))
    {
        //printf("%d-",x);
        if(c==m)
        {
            r++;
            c=0;
        }
        matrix[r][c++]=x;
    }

    fclose(fp);
}

void writeMatrix(int matrix[n][m])
{
    FILE *fp;
    fp=fopen("final.txt","a");
    for(int i=0;i<n;++i)
    {
        for(int j=0;j<m;++j)
        {
            fprintf(fp,"%d, ",matrix[i][j]);
        }
        fprintf(fp,"\n");
    }

    fclose(fp);
}

int main(int argc, char* argv[])
{
    int r[n][m],g[n][m],b[n][m];

    int id = 0;
    int comm_size = 0;

    int final[n][m];
```

```
int start,siz;
readMatrix(r,0);
readMatrix(g,1);
readMatrix(b,2);

double t1, t2;
t1 = MPI_Wtime();

MPI_Init(&argc, &argv);

MPI_Comm_rank(MPI_COMM_WORLD, &id);
MPI_Comm_size(MPI_COMM_WORLD, &comm_size);
start=n%comm_size;
siz=n/comm_size;
if(id==0)
{
   readMatrix(r,0);
   readMatrix(g,1);
   readMatrix(b,2);

   printf("Name: S Shyam Sundaram\nReg num: 19BCE1560\n\n");
   printf("%d and %d\n",start,siz);
   if(start!=0)
   {
      for(int i=0;i<start;++i)
      for(int j=0;j<m;++j)
      final[i][j]=(r[i][j]+g[i][j]+b[i][j])/3;
   }
}
int rrow[m*siz],grow[m*siz],brow[m*siz], avg[m*siz];
MPI_Scatter(r[start], siz*m, MPI_INT, rrow, siz*m, MPI_INT, 0, MPI_COMM_WORLD);
MPI_Scatter(g[start], siz*m, MPI_INT, grow, siz*m, MPI_INT, 0, MPI_COMM_WORLD);
MPI_Scatter(b[start], siz*m, MPI_INT, brow, siz*m, MPI_INT, 0, MPI_COMM_WORLD);

for(int k=0;k<m*siz;++k)
   avg[k]=(rrow[k]+grow[k]+brow[k])/3;

if(start<m)
MPI_Gather(avg,siz*m,MPI_INT,final[start],siz*m,MPI_INT,0,MPI_COMM_WORLD);

if(id==0)
{
   printf("Final is matrix written to file \n");
```

```
        writeMatrix(final);
    }

    MPI_Finalize();
    t2 = MPI_Wtime();
    printf( "Elapsed time is %f\n", t2 - t1 );
    return 0;
}
```

getrgb.py

```
import numpy as np
from PIL import Image

img=Image.open('img1.jpg')
arr=np.array(img)
print(arr.shape)
print(arr)

r=open("r.txt","a")
g=open("g.txt","a")
b=open("b.txt","a")
for i in range(arr.shape[0]):
    for j in range(arr.shape[1]):
        r.write(str(arr[i][j][0]).rstrip('\n')+", ")
        g.write(str(arr[i][j][1]).rstrip('\n')+", ")
        b.write(str(arr[i][j][2]).rstrip('\n')+", ")
    r.write("\n")
    g.write("\n")
    b.write("\n")
r.close()
g.close()
b.close()
```

writeimg.py

```
import numpy as np
import matplotlib.pyplot as plt

f=open("final.txt","r")
l=f.readlines()
pix=[]
for i in range(len(l)):
    li=[int(x) for x in l[i].split(", ")[:-1]]
    pix.append(li)
```

```
pix=np.array(pix)
print(pix.shape)
print(pix)
plt.imshow(pix, cmap="gray")
plt.show()
```

COMMANDS

```
python getrgb.py
mpicc avg.c
mpirun --oversubscribe -np 4 ./a.out
python writeimg.py
```

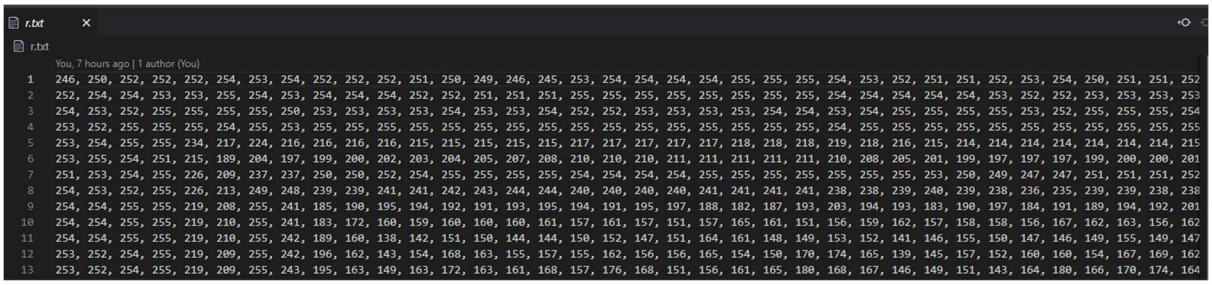
OUTPUT

```
(MachineLearning) shyam@shyam-Inspiron-14-5408:~/Academics/Lab-Fall-2021/PDC/Lab12$ mpicc avg.c
(MachineLearning) shyam@shyam-Inspiron-14-5408:~/Academics/Lab-Fall-2021/PDC/Lab12$ mpirun -np 4 ./a.out
Name: S Shyam Sundaram
Reg num: 19BCE1560

3 and 119
Final is matrix written to file
Elapsed time is 0.568415
Elapsed time is 0.569588
Elapsed time is 0.573728
Elapsed time is 0.622162
```

avg.c with 4 processes

```
(MachineLearning) shyam@shyam-Inspiron-14-5408:~/Academics/Lab-Fall-2021/PDC/Lab12$ mpirun -np 3 ./a.out
Name: S Shyam Sundaram
Reg num: 19BCE1560

2 and 159
Final is matrix written to file
Elapsed time is 0.560012
Elapsed time is 0.556266
Elapsed time is 0.608360
```

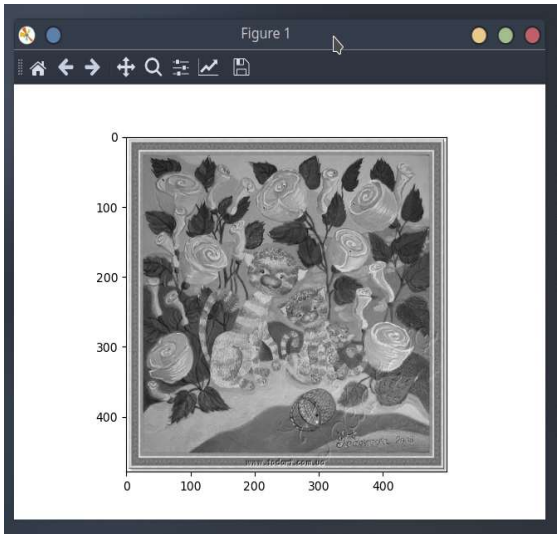
avg.c with 3 processes



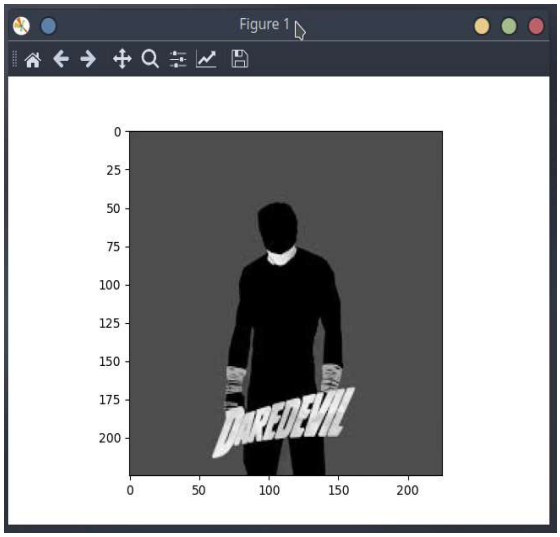
Text file holding R values of all pixels: r.txt. G and B values stored in g.txt and b.txt respectively.

Image used: img1.jpg

Image used: images.jpg



FInal grayscale of img1.jpg

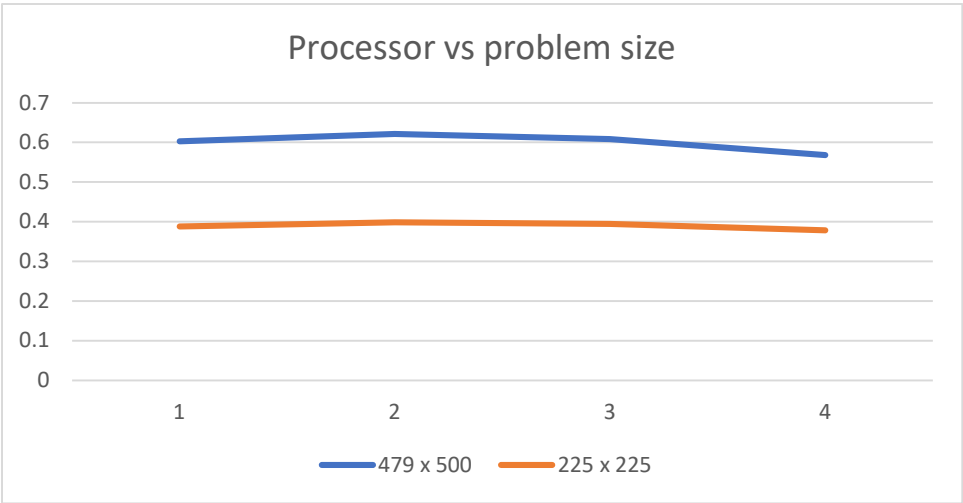


FInal grayscale of images.jpg

OBSERVATION

Each process gets a set of rows from the R, G and B matrices. Their average is calculated and written back into a text file to be read by another python program that forms the resultant image which is grayscale.

Height x Width	NUMBER OF PROCESSES	TIME
479 x 500	1	0.602425
	2	0.621714
	3	0.608360
	4	0.568415
225x225	1	0.387871
	2	0.398878
	3	0.394761
	4	0.378416



CONCLUSION

We have computed the average of R, G and B matrices and formed a grayscale image.