Parallel Sorting Assignment Report

Parallel Bucketsort via MPI

BY

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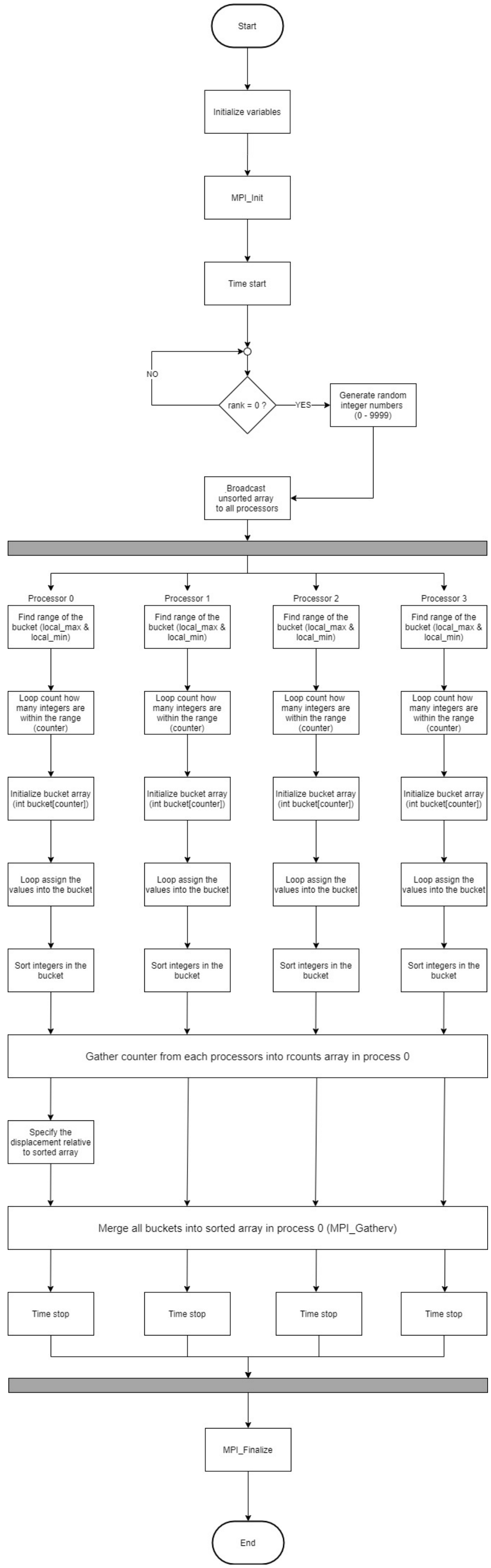
Explanation of the Source Code as a Flowchart



Testing Results with Sample Capture Screen Shots

1. 10,000 random integer numbers

```
/project $ mpicc -o out bucketsort.c
/project $ mpirun -np 1 ./out
Process 0 took 0.319473 seconds to run.
/project $ mpirun -np 2 ./out
Process 1 took 0.163924 seconds to run.
Process 0 took 0.171179 seconds to run.
/project $ mpirun -np 3 ./out
Process 2 took 0.105898 seconds to run.
Process 1 took 0.139083 seconds to run.
Process 0 took 0.141575 seconds to run.
/project $ mpirun -np 4 ./out
Process 1 took 0.105823 seconds to run.
Process 2 took 0.123137 seconds to run.
Process 3 took 0.127459 seconds to run.
Process 0 took 0.142905 seconds to run.
```

2. 100,000 random integer numbers

```
/project $ mpicc -o out bucketsort.c
/project $ mpirun -np 1 ./out
Process 0 took 18.340747 seconds to run.
/project $ mpirun -np 2 ./out
Process 1 took 9.201187 seconds to run.
Process 0 took 9.211407 seconds to run.
/project $ mpirun -np 3 ./out
Process 2 took 6.090886 seconds to run.
Process 1 took 6.092352 seconds to run.
Process 0 took 6.102874 seconds to run.
/project $ mpirun -np 4 ./out
Process 1 took 4.557874 seconds to run.
Process 2 took 4.658165 seconds to run.
Process 3 took 4.694629 seconds to run.
Process 0 took 4.728061 seconds to run.
```

Parallel Image [Running] - Oracle VM VirtualBox

```
 9308 9308 9309 9310 9311 9313 9313 9314 9315 9319 9321 9323 9325 9326 9327 9328 9330 9331 9331 9333
 9333 9334 9334 9336 9337 9338 9339 9339 9340 9340 9340 9341 9342 9342 9342 9343 9345 9345 9346 9346
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 9400 9401 9401 9402 9402 9404 9404 9405 9408 9408 9409 9410 9410 9410 9411 9411 9411 9412 9413 9415
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 9436 9436 9438 9440 9441 9442 9444 9445 9446 9448 9449 9449 9452 9452 9452 9454 9455 9455 9456 9458
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 9509 9509 9510 9511 9511 9513 9514 9517 9517 9518 9518 9518 9520 9521 9521 9522 9523 9523 9525 9525
 9526 9526 9527 9528 9530 9532 9532 9534 9535 9535 9535 9535 9536 9537 9537 9539 9539 9540 9541 9542
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 9664 9664 9666 9667 9668 9669 9670 9671 9671 9672 9674 9675 9676 9677 9679 9680 9680 9683 9686 9686
 9688 9688 9691 9691 9692 9694 9696 9696 9699 9699 9700 9700 9700 9701 9704 9705 9706 9706 9706 9706
 9707 9707 9709 9710 9710 9710 9713 9714 9715 9716 9716 9717 9717 9718 9718 9719 9720 9721 9721 9723
 9723 9727 9728 9731 9732 9732 9734 9734 9734 9736 9738 9742 9743 9745 9745 9746 9747 9748 9748 9749
 9751 9754 9755 9756 9759 9761 9761 9762 9763 9763 9764 9765 9766 9766 9768 9769 9769 9772 9774 9776
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 9905 9908 9908 9909 9910 9912 9912 9914 9915 9915 9916 9918 9920 9921 9922 9923 9924 9924 9925 9927
 9927 9927 9927 9928 9928 9929 9931 9933 9933 9933 9933 9934 9935 9935 9936 9937 9937 9938 9938 9938
 9939 9940 9941 9943 9944 9946 9946 9947 9950 9951 9953 9955 9956 9958 9960 9960 9960 9961 9961 9962
 9963 9964 9964 9965 9965 9967 9967 9967 9969 9970 9970 9975 9977 9979 9981 9984 9986 9987 9988 9989
 9989 9989 9991 9992 9994 9996 9997 9997 9997 9998 9999 9999 /project $
/project $
```

Speedup Graph for 1 to 4 processors

$$S(p) = \frac{Sequential\ execution\ time}{Parallel\ execution\ time} = \frac{t_s}{t_p}$$

As t_p is the total runtime of the slowest process, we can calculate the Speedup as follows:

1. 10,000 random integer numbers

$$S(1) = \frac{0.319473}{0.319473} = 1$$

$$S(2) = \frac{0.319473}{0.171179} = 1.866$$

$$S(3) = \frac{0.319473}{0.141575} = 2.257$$

$$S(4) = \frac{0.319473}{0.142905} = 2.236$$

2. 100,000 random integer numbers

$$S(1) = \frac{18.340747}{18.340747} = 1$$

$$S(1) = \frac{18.340747}{9.211407} = 1.991$$

$$S(1) = \frac{18.340747}{6.102874} = 3.005$$

$$S(1) = \frac{18.340747}{4.728061} = 3.879$$

3. 1,000,000 random integer numbers

There is no data to show for 1,000,000 random integer numbers as the memory of the VMware is insufficient.

Note: 1 int array = 4 bytes therefore if we generate 1,000,000 array size, 4MB of memory is needed. Also, we broadcast the copy of the array to 4 processors so, 12MB of memory is needed in total.

```
/project $ mpicc -o out bucketsort.c
/project $ mpirun -np 4 ./out

===================================================================================
=   BAD TERMINATION OF ONE OF YOUR APPLICATION PROCESSES
=   PID 83 RUNNING AT 172.18.0.3
=   EXIT CODE: 139
=   CLEANING UP REMAINING PROCESSES
=   YOU CAN IGNORE THE BELOW CLEANUP MESSAGES
===================================================================================
```