Университет ИТМО

Лабораторная работа №1
по дисциплине
“Высокопроизводительные системы”

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Цели работы:

Реализовать алгоритмы сортировки Quicksort и Smoothsort (быстрая и плавная сортировки). Параллелизовать реализованные алгоритмы с помощью OpenMP, применяя для каждого общий набор из разных подходов для распределения частей работы и объединения результатов. Собрать статистику о времени работы реализованных алгоритмов и отдельных этапов в реализациях для различных наборов входных данных в сочетании с различными степенями параллелизма. Сравнить все полученные реализации и объяснить результаты.

Задачи:

- Реализовать алгоритм сортировки Quicksort
- Реализовать алгоритм сортировки Smoothsort
- Параллелизовать алгоритмы сортировки с помощью OpenMP
- Сравнить полученные результаты

Описание работы:

В работе реализованы следующие компоненты:

- main - точка входа в программу
- quick_sort - файлы с реализацией алгоритма сортировки quick_sort
- smooth_sort - файлы с реализацией алгоритма сортировки smooth_sort
- test_utils - вспомогательные файлы для тестирования алгоритмов сортировки
- array_utils - вспомогательные файлы для работы с массивами

Результаты:

Single-threaded quick sort
Starting 5 test(s) on 5000000 elements...
Test 1 finished in 0.96s and used 0.96s of cpu time.
Test 2 finished in 0.98s and used 0.98s of cpu time.
Test 3 finished in 0.98s and used 0.98s of cpu time.
Test 4 finished in 1.04s and used 1.04s of cpu time.
Test 5 finished in 0.90s and used 0.90s of cpu time.
Mean real time is: 0.97 seconds
Mean cpu time is: 0.97 seconds

Single-threaded Smooth Sort
Starting 5 test(s) on 5000000 elements...
Test 1 finished in 4.00s and used 4.01s of cpu time.
Test 2 finished in 3.71s and used 3.71s of cpu time.
Test 3 finished in 3.71s and used 3.71s of cpu time.
Test 4 finished in 3.66s and used 3.66s of cpu time.
Test 5 finished in 3.73s and used 3.73s of cpu time.
Mean real time is: 3.76 seconds

Mean cpu time is: 3.76 seconds

При 2 потоках openmp:
Multi-threaded quick sort
Starting 5 test(s) on 5000000 elements...
Test 1 finished in 0.31s and used 2.04s of cpu time.
Test 2 finished in 0.36s and used 2.39s of cpu time.
Test 3 finished in 0.45s and used 2.90s of cpu time.
Test 4 finished in 0.37s and used 2.40s of cpu time.
Test 5 finished in 0.35s and used 2.29s of cpu time.
Mean real time is: 0.37 seconds
Mean cpu time is: 2.40 seconds
Total acceleration acceleration_rate is 6.51

Multi-threaded Smooth Sort
Starting 5 test(s) on 5000000 elements...
Test 1 finished in 1.30s and used 7.55s of cpu time.
Test 2 finished in 1.29s and used 7.64s of cpu time.
Test 3 finished in 1.28s and used 6.81s of cpu time.
Test 4 finished in 1.23s and used 6.55s of cpu time.
Test 5 finished in 1.42s and used 8.36s of cpu time.
Mean real time is: 1.30 seconds
Mean cpu time is: 7.38 seconds
Total acceleration acceleration_rate is 5.66!

При 4 потоках openmp:
Multi-threaded quick sort
Starting 5 test(s) on 5000000 elements...
Test 1 finished in 0.35s and used 2.28s of cpu time.
Test 2 finished in 0.35s and used 2.30s of cpu time.
Test 3 finished in 0.37s and used 2.40s of cpu time.
Test 4 finished in 0.37s and used 2.46s of cpu time.
Test 5 finished in 0.37s and used 2.42s of cpu time.
Mean real time is: 0.36 seconds
Mean cpu time is: 2.37 seconds
Total acceleration acceleration_rate is 6.51!

Multi-threaded Smooth Sort
Starting 5 test(s) on 5000000 elements...
Test 1 finished in 1.23s and used 6.64s of cpu time.
Test 2 finished in 1.24s and used 7.09s of cpu time.
Test 3 finished in 1.34s and used 7.59s of cpu time.
Test 4 finished in 1.36s and used 8.22s of cpu time.
Test 5 finished in 1.23s and used 7.05s of cpu time.

Mean real time is: 1.28 seconds
Mean cpu time is: 7.32 seconds
Total acceleration acceleration_rate is 5.70!

При 8 потоках openmp:
Multi-threaded quick sort
Starting 5 test(s) on 5000000 elements...
Test 1 finished in 0.34s and used 2.26s of cpu time.
Test 2 finished in 0.38s and used 2.50s of cpu time.
Test 3 finished in 0.38s and used 2.49s of cpu time.
Test 4 finished in 0.37s and used 2.42s of cpu time.
Test 5 finished in 0.36s and used 2.30s of cpu time.
Mean real time is: 0.37 seconds
Mean cpu time is: 2.39 seconds
Total acceleration acceleration_rate is 6.52!

Multi-threaded Smooth Sort
Starting 5 test(s) on 5000000 elements...
Test 1 finished in 1.23s and used 6.34s of cpu time.
Test 2 finished in 1.38s and used 7.04s of cpu time.
Test 3 finished in 1.31s and used 6.93s of cpu time.
Test 4 finished in 1.26s and used 6.74s of cpu time.
Test 5 finished in 1.25s and used 6.40s of cpu time.
Mean real time is: 1.28 seconds
Mean cpu time is: 6.69 seconds
Total acceleration acceleration_rate is 5.21!

Выводы:

По временным характеристикам quicksort эффективнее smoothsort при однопоточном и многопоточных исполнениях.
С помощью грамотного использования OpenMP можно уменьшить время исполнения работы алгоритма в 3-4 раза по сравнению с однопоточной работой.