ОТЧЕТ ПО ЗАДАНИЮ

«Реализация алгоритма 3D ADI с использованием графических процессоров»

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1 Постановка задачи

1. Реализовать параллельный алгоритм 3-х мерного ADI по данному последовательному алгоритму.

2. Оценить ускорение программы по отношению к последовательной версии.

2 Описание программы

3 Результаты работы программы в зависимости от выбора размера блока нитей

Size = 384 x 384 x 384
Iterations = 100
Operation type = double precision
Параллельное выполнение, симметричный блок:

dim3 block = dim3(1, 1, 1);
dim3 thread = dim3(384, 384, 384);
SEGFAULT

dim3 block = dim3(2, 2, 2);
dim3 thread = dim3(192, 192, 192);
SEGFAULT

dim3 block = dim3(4, 4, 4);
dim3 thread = dim3(96, 96, 96);
SEGFAULT

dim3 block = dim3(8, 8, 8);
dim3 thread = dim3(48, 48, 48);
SEGFAULT

dim3 block = dim3(16, 16, 16);
dim3 thread = dim3(24, 24, 24);
SEGFAULT

dim3 block = dim3(32, 32, 32);
dim3 thread = dim3(12, 12, 12);
SEGFAULT

dim3 block = dim3(39, 39, 39);
dim3 thread = dim3(10, 10, 10);
ADI Benchmark Completed.
Time in seconds = 36.63
Verification = SUCCESSFUL

dim3 block = dim3(40, 40, 40);
dim3 thread = dim3(10, 10, 10);
ADI Benchmark Completed.
Time in seconds = 39.18
Verification = SUCCESSFUL

dim3 block = dim3(43, 43, 43);
dim3 thread = dim3(9, 9, 9);
ADI Benchmark Completed.
Time in seconds = 35.20
Verification = SUCCESSFUL

dim3 block = dim3(48, 48, 48);
dim3 thread = dim3(8, 8, 8);
ADI Benchmark Completed.
Time in seconds = 30.45
Verification = SUCCESSFUL

dim3 block = dim3(55, 55, 55);
dim3 thread = dim3(8, 8, 8);
ADI Benchmark Completed.
Time in seconds = 44.39
Verification = SUCCESSFUL

dim3 block = dim3(55, 55, 55);
dim3 thread = dim3(7, 7, 7);
ADI Benchmark Completed.
Time in seconds = 30.69
Verification = SUCCESSFUL

dim3 block = dim3(64, 64, 64);
dim3 thread = dim3(6, 6, 6);
ADI Benchmark Completed.
Time in seconds = 46.37
Verification = SUCCESSFUL

dim3 block = dim3(128, 128, 128);
dim3 thread = dim3(3, 3, 3);
ADI Benchmark Completed.
Time in seconds = 359.92
Verification = SUCCESSFUL

Вывод: Для заданных начальных условий оптимальный выбор:
dim3 block = dim3(48, 48, 48);
dim3 thread = dim3(8, 8, 8);

Size = 384 x 384 x 384
Iterations = 100
Operation type = double precision
Параллельное выполнение, асимметричный блок:

dim3 block = dim3(24, 96, 192);
dim3 thread = dim3(16, 4, 2);
ADI Benchmark Completed.
Time in seconds = 77.36
Verification = SUCCESSFUL

dim3 block = dim3(6, 48, 192);
dim3 thread = dim3(64, 8, 2);
ADI Benchmark Completed.
Time in seconds = 33.56
Verification = SUCCESSFUL

dim3 block = dim3(12, 96, 384);
dim3 thread = dim3(32, 4, 1);
ADI Benchmark Completed.
Time in seconds = 77.27
Verification = SUCCESSFUL

dim3 block = dim3(12, 24, 192);
dim3 thread = dim3(32, 16, 2);
ADI Benchmark Completed.
Time in seconds = 34.03
Verification = SUCCESSFUL

dim3 block = dim3(24, 48, 96);
dim3 thread = dim3(16, 8, 4);
ADI Benchmark Completed.
Time in seconds = 29.90
Verification = SUCCESSFUL

dim3 block = dim3(12, 48, 96);
dim3 thread = dim3(32, 8, 4);
ADI Benchmark Completed.
Time in seconds = 33.70
Verification = SUCCESSFUL

dim3 block = dim3(12, 48, 192);
dim3 thread = dim3(32, 8, 2);
ADI Benchmark Completed.
Time in seconds = 29.83
Verification = SUCCESSFUL

dim3 block = dim3(3, 48, 192);
dim3 thread = dim3(128, 8, 2);
SEGFAULT

Вывод: Для заданных начальных условий оптимальный выбор:
dim3 block = dim3(12, 48, 192);
dim3 thread = dim3(32, 8, 2);

4 Результаты работы программы в зависимости от выбора индексов i, j, k.

Size = 384 x 384 x 384
Iterations = 100
Operation type = double precision
dim3 block = dim3(48, 48, 48);
dim3 thread = dim3(8, 8, 8);
Параллельное выполнение:
Для всех функций:
int i = blockIdx.x * blockDim.x + threadIdx.x;
int j = blockIdx.y * blockDim.y + threadIdx.y;
int k = blockIdx.z * blockDim.z + threadIdx.z;

Функция f1, время выполнения функции adi_parallel:

i = x, k = y, j = z
Time in seconds = 39.34
j = x, i = y, k = z
Time in seconds = 39.40
k = x, i = y, j = z
Time in seconds = 39.29
j = x, k = y, i = z
Time in seconds = 39.23
k = x, j = y, i = z
Time in seconds = 39.21

Функция f2, время выполнения функции adi_parallel:

i = x, k = y, j = z
Time in seconds = 39.24
j = x, i = y, k = z
Time in seconds = 39.34
k = x, i = y, j = z
Time in seconds = 39.18
j = x, k = y, i = z
Time in seconds = 39.35
k = x, j = y, i = z
Time in seconds = 39.31

Функция f3, время выполнения функции adi_parallel:

i = x, k = y, j = z
Time in seconds = 30.54
j = x, i = y, k = z
Time in seconds = 39.36
k = x, i = y, j = z
Time in seconds = 30.46
j = x, k = y, i = z
Time in seconds = 30.42
k = x, j = y, i = z
Time in seconds = 30.44

Вывод: Для заданных начальных условий оптимальный выбор:
f1: k = x, j = y, i = z
f2: k = x, i = y, j = z
f3: j = x, k = y, i = z

5 Результаты работы программы на различных входных данных

$$\text{dim3 block} = \text{dim3}(48, 48, 48);$$
$$\text{dim3 thread} = \text{dim3}(8, 8, 8);$$

Последовательное выполнение:

ADI Benchmark Completed.
Size = 100 x 100 x 100
Iterations = 100
Time in seconds = 0.93
Operation type = double precision
Verification = SUCCESSFUL
END OF ADI Benchmark

ADI Benchmark Completed.
Size = 384 x 384 x 384
Iterations = 100
Time in seconds = 57.97
Operation type = double precision
Verification = SUCCESSFUL
END OF ADI Benchmark

ADI Benchmark Completed.
Size = 500 x 500 x 500
Iterations = 100
Time in seconds = 127.33
Operation type = double precision
Verification = SUCCESSFUL
END OF ADI Benchmark

ADI Benchmark Completed.
Size = 500 x 500 x 500
Iterations = 200
Time in seconds = 256.04
Operation type = double precision
Verification = SUCCESSFUL
END OF ADI Benchmark

Параллельное выполнение:

ADI Benchmark Completed.
Size = 100 x 100 x 100
Iterations = 100
Time in seconds = 0.52
Operation type = double precision
Verification = SUCCESSFUL
END OF ADI Benchmark

ADI Benchmark Completed.
Size = 384 x 384 x 384
Iterations = 100
Time in seconds = 30.14
Operation type = double precision
Verification = SUCCESSFUL
END OF ADI Benchmark

ADI Benchmark Completed.
Size = 500 x 500 x 500
Iterations = 100
Time in seconds = 86.13
Operation type = double precision
Verification = SUCCESSFUL
END OF ADI Benchmark

ADI Benchmark Completed.
Size = 500 x 500 x 500
Iterations = 200
Time in seconds = 171.96
Operation type = double precision
Verification = SUCCESSFUL
END OF ADI Benchmark

dim3 block = dim3(12, 48, 192);
dim3 thread = dim3(32, 8, 2);

Последовательное выполнение:

ADI Benchmark Completed.
Size = 100 x 100 x 100
Iterations = 100
Time in seconds = 0.93
Operation type = double precision
Verification = SUCCESSFUL
END OF ADI Benchmark

ADI Benchmark Completed.
Size = 384 x 384 x 384
Iterations = 100
Time in seconds = 58.20
Operation type = double precision
Verification = SUCCESSFUL
END OF ADI Benchmark

ADI Benchmark Completed.
Size = 500 x 500 x 500
Iterations = 100
Time in seconds = 127.45
Operation type = double precision
Verification = SUCCESSFUL
END OF ADI Benchmark

ADI Benchmark Completed.
Size = 500 x 500 x 500
Iterations = 200
Time in seconds = 256.08
Operation type = double precision
Verification = SUCCESSFUL
END OF ADI Benchmark

Параллельное выполнение:

ADI Benchmark Completed.
Size = 100 x 100 x 100
Iterations = 100
Time in seconds = 0.55
Operation type = double precision
Verification = SUCCESSFUL
END OF ADI Benchmark

ADI Benchmark Completed.
Size = 384 x 384 x 384
Iterations = 100
Time in seconds = 29.82
Operation type = double precision
Verification = SUCCESSFUL
END OF ADI Benchmark

ADI Benchmark Completed.
Size = 500 x 500 x 500
Iterations = 100
Time in seconds = 86.21
Operation type = double precision
Verification = SUCCESSFUL
END OF ADI Benchmark

ADI Benchmark Completed.
Size = 500 x 500 x 500
Iterations = 200
Time in seconds = 172.34
Operation type = double precision
Verification = SUCCESSFUL
END OF ADI Benchmark

6 Сравнение скорости работы алгоритмов

Последовательный алгоритм:

Теоретическая оценка: $O(I * nx * ny * nz)$

Параллельный алгоритм:

Теоретическая оценка: $O(I * max(nx, ny, nz) * ???)$