امیرحسین پاشایی هیر ۹۷۳۱۰۱۳

سوال ۱:

برای پیاده سازی الگوریتم، هر مرحله (i) الگوریتم (که $log_2(n)$ مرحله وجود دارد) یک کرنل برای کارت گرافیک ارسال شده و این کرنل برای اندیس‌های بزرگتر از 2^i مقدار هر اندیس را با مقدار آن در 2^i خانه‌ی قبل او جمع می‌زند.

چک کردن صحت کد برای $n = 2048$:

```
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چک کردن صحت کد برای $n = 1024$:

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```

سوال ۲:

در تمام آزمایش‌ها، الگوریتم موازی با اندازه‌ی بلاک ۳۲ اجرا شده است.

n	زمان کد موازی (ms)	زمان کد سریال (ms)	speedup
16777216	77	95	1.23
33554432	150	253	1.68
67108864	306	486	1.58

امیرحسین پاشایی هیر ۹۷۳۱۰۱۳

سوال ۳:

جدول زمان اجرا برای $n = 67108864$ بر اساس اندازه‌ی بلوک‌های مختلف:

اندازه‌ی بلاک	زمان (ms)
16	510
32	302
64	438
128	434
256	422
512	426
1024	419

با توجه به جدول ۳۲ بهترین اندازه است. به دلیل اینکه کرنل بسیار سبک است (هیچ حافظه‌ای استفاده نکرده و فقط چند بایت رجیستر مصرف می‌کند) هر چه اندازه بلاک کوچک‌تر باشد تعداد بلاک‌های آماده‌ی اجرا شدن زیاد شده و occupancy بالا می‌رود، از طرفی اگر اندازه‌ی بلاک کمتر از warp size باشد، مشکل عدم استفاده بهینه از هر warp به وجود می‌آید. به همین دلیل ۳۲ بهترین مقدار برای اندازه‌ی بلوک می‌باشد.

a. بله، اگر n از 2^i بزرگتر باشد، ۳۲ بهترین مقدار خواهد بود.

b. با توجه به مشخصات device:

```
        size_t {aka long unsigned int}
compiled
There is 1 device supporting CUDA

Device 0: "NVIDIA GeForce MX450"
  Major revision number:                         7
  Minor revision number:                         5
  Total amount of global memory:                 1969815552 bytes
  Number of multiprocessors:                     14
  Number of cores:                               112
  Total amount of constant memory:               65536 bytes
  Total amount of shared memory per block:       49152 bytes
  Total number of registers available per block: 65536
  Warp size:                                     32
  Maximum number of threads per block:           1024
  Maximum sizes of each dimension of a block:    1024 x 1024 x 64
  Maximum sizes of each dimension of a grid:     2147483647 x 65535 x 65535
  Maximum memory pitch:                          2147483647 bytes
  Texture alignment:                             512 bytes
  Clock rate:                                    1.58 GHz
  Concurrent copy and execution:                 Yes

TEST PASSED
→ lab5
```

در کارت گرافیک مقصد ۱۴ sm وجود دارد که هر کدام ۸ هسته دارند، هر بلاک به ۴ قسمت تقسیم شده و هر قسمت در sm اجرا می‌شود، با توجه به تعداد زیاد بلوک‌ها در n های بزرگ، از تمام ظرفیت stmها به خوبی استفاده می‌شود.

امیرحسین پاشایی هیر ۹۷۳۱۰۱۳

سوال ۴:

n	الگوریتم تقسیم Omp	Omp Hillis and Steele	GPU Hillis and Steele
65536	1.268	7.32	0.501
1048576	10.2	15.1	2.4
33554432	248	185	155

الگوریتم Hillis and steele در حالتی که تعداد sp ها در sm ها زیاد باشد، به سمت $O(log_2(n))$ شدن الگوریتم حرکت می‌کند، دلیل برتری آن نسبت به دو حالت موازی سازی شده با omp همین است، در این آزمایش نیز تعداد sp ها به اندازه‌ای بوده که speedup دو برابر نسبت به بهترین حالت موازی سازی با omp (که حداکثر به اندازه تعداد هسته‌های cpu می‌باشد) حاصل شود.

سوال ۵:

تمام اجراهای زیر با اندازه بلاک ۳۲ و $n = 67108864$ اجرا شده‌اند.

Data type	زمان (ms)
int	306
float	315
double	538

چون اندازه‌ی float و int برابر است (۴ بایت)، زمان اجرای مساوی دارند اما اندازه‌ی double دو برابر بود (۸ بایت) و طبعا عملیات‌های متناظر با آن، اندازه‌ی حافظه اشغالی و تعداد رجسیترهای مورد استفاده آن نیز دو برابر خواهد شد.