

Summer Semester 2014

Assignment on Massively Parallel Algorithms - Sheet 8

Due Date 02. 07. 2014

Exercise 1 (Prefix Sums Theoretical Exercise, 8 Credits)

- a) Analyze the parallel scan kernel using 1 block given below . Show that thread divergence only occurs in the first warp for stride values up to half of the warp size. That is, for warp size 32, control divergence will occur to iterations for stride values 1, 2, 4, 8, and 16.

Hint: Refer Hillis Steele Algorithm in lecture slides

```
template<int INPUT_SIZE> __global__ void hillis_steele_scan_kernel(float *X,
                                                                float *Y, int InputSize)
{
    __shared__ float XY[INPUT_SIZE];
    int i = threadIdx.x;
    if (i < InputSize)
    {
        XY[threadIdx.x] = X[i];
    }

    // the code below performs iterative scan on XY
    for (unsigned int stride = 1; stride <= threadIdx.x; stride *= 2)
    {
        __syncthreads();
        XY[threadIdx.x] += XY[threadIdx.x-stride];
    }

    Y[i] = XY[threadIdx.x];
}

////////////////////////////////////*kernel launch*////////////////////////////////////
hillis_steele_scan_kernel<INPUT_SIZE><<<<1, INPUT_SIZE>>>>(X, Y, InputSize);
```

- b) For the work efficient scan kernel (Blelloch algorithm), assume that we have 2048 elements, how many add operations will be performed in both the up sweep phase and the down sweep phase?
- c) Analyze the Blelloch Algorithm for arbitrary length input presented in lecture slides (hierarchical parallel scan algorithm) and show that it is work efficient and the total number of additions is no more than $4*N-3$
- d) Describe a massively parallel algorithm that computes the minimum of an array with depth complexity $O(\log n)$.
- e) Explain why it is necessary for the \oplus operator in the definition of any prefix sum to be associative.