GEOMETRIC and GRAPHICS ALGORITHMS **on KESTREL**

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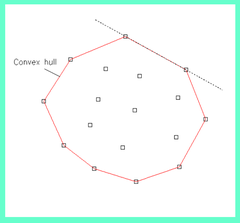
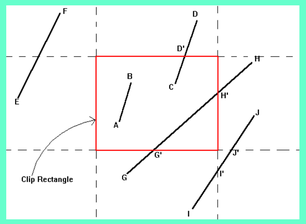


W h a t ?

- New algorithm for 2D convex hull problem on linear SIMD machines employing Systolic Shared Registers
- Study the parallel performance of Cohen-Sutherland and Liang-Barsky clipping algorithms



ConvexHullPROBLEM

W h y ?

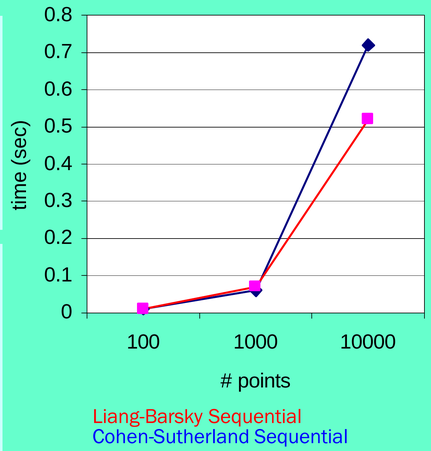
- Communication between adjacent processors are fast, ideal for bubble sort and local convex hull computations
- Simple idea, easily extended from sequential algorithm
- Computational geometry is fun!

H o w ?

- Replace-and-shift approach
- Every processor is assigned one planar point, and its two lexicographic-sorted adjacent neighbors
- Perform right-hand-turn (RHT) test on all processors (parallelism)
- If triplet fails the RHT test, replace middle point with last point (replace)
- If two adjacent points P and Q are the same, replace Q with Q's right-adjacent point (shift)

R e s u l t s

- Odd-even transposition sorting has complexity O(n), requires at most 2n-6 iterations for applying right-hand-turn test, hence:
- Parallel complexity of O(n), with constant factor 2
- If right-hand-turn test returns false for collinear points, the shift phase can be eliminated
- Implemented 3-layer algorithm that supports input size from 1025 to 1536 points
- To support bigger or smaller dataset size, need to implement more or less layers, respectively
- Limited simulation results are shown in charts to the right



S e q u e n t i a l
(sundance)

1025 pts:	0.01 s
1536 pts:	0.01 s
5000 pts:	0.05 s
8000 pts:	0.06 s
10000pts:	0.06 s

P a r a l l e l
(Kestrel)
1025 pts:
1536 pts:

ClippingALGORITHMS

W h y ?

- Apparent data-parallelism, suitable for SIMD machines
- Of fundamental importance in graphics rendering
- Initial work to decide if future graphics applications feasible on Kestrel?

H o w ?

- Load points in array
- Each processor is assigned a pair of endpoints
- Independent data
- Perform sequential algorithm simultaneously on all processors

R e s u l t s

- Cohen-Sutherland does not perform well (many conditionals)
- Theoretically worse than brute-force approach
- Parallel Liang-Barsky outperforms Cohen-Sutherland by approximately 10 times
- Limited analysis based on number of binary code lines generated for each implementation on Kestrel.
- Has yet to determine the factor of improvement between parallel and sequential implementations

T H A N K S ! SURF-IT, NSF REU 0244016

R e f e r e n c e s

[1] Hearn, Donald and Baker, M. Pauline, Computer Graphics: C Version
[2] de Berg et al., Computational Geometry: Algorithms and Applications
[3] Kumar et al., Intro. To Parallel Computing: Design & Analysis of Algorithms