Parallel computing techniques in CAD drawing analysis

INTRODUCTION

Sketches obtained as a result of import or export from different CAD packages to DXF/DWG formats often contain broken geometry relations: broken tangent, broken horizontal or vertical relations, gaps between entities, etc. Broken sketches can create problems when creating 3D models, and in generating production manufacturing information.

Repairing broken sketches manually is not practical. The amount of data to be processed, especially for big complex documents, presents a problem even for automated solutions.

The goal of this article is to demonstrate that application of multiprocessor/multi-core technologies can significantly improve sketch repair process performance. processed, especially for big complex documents, presents a problem even for automated solutions.

APPROACH

To demonstrate application of the multi-processor/multi-core approach to analysis and modification of DXF sketches, the Sketch Repair program developed by AMC Bridge LLC was used.

Sketch Repair enables users to analyze drawing files for the following broken relations types with given tolerances:

- Line is almost horizontal/vertical
- Lines are almost parallel/perpendicular
- Arcs, circles, ellipses are almost concentric
- Entities' end points are very close to coincident

The original drawing analysis program was written for the sequential execution of the analysis and repair algorithm. For the purpose of this research, the original code was modified to take advantage of a multi-processor/multi-core environment.

Two versions of parallel implementation of Sketch Repair were developed. One was created using ConcRT - Microsoft Concurrency Runtime[1] which was introduced with Microsoft Visual Studio 2010. The second version was developed with OpenMP[2] , also part of Microsoft Visual Studio.

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RESULTS

Test runs on the sequential version of the program and two versions modified for parallel executions were performed on a drawing file with the following properties:

- 160608 unique points
- 163017 lines
- 1755 arcs
- 14 circles

Figure 1 below shows side-by-side results of the test runs.

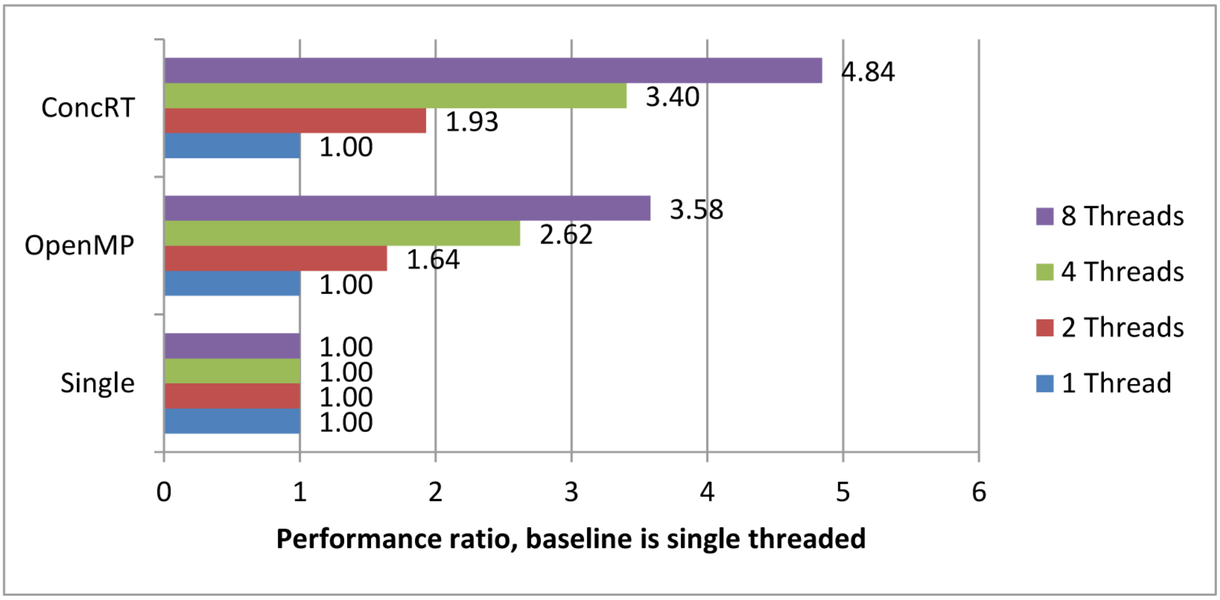

Figure 1. Parallel lines task speedup, regarding to single thread

As the chart demonstrates, parallel execution significantly accelerates the sketch repair process in speed of execution when the number of cores is increased. Each additional physical core increases performance by 75% for the software implemented using OpenMP, and by about 85% for the version developed using ConcRT. Two requirements are key to achieving significant performance improvement for parallel analysis: (1) use of synchronization techniques must be reduced to the minimum, and (2) data must be constant during the analysis process.

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SUMMARY

Investment in modifying or creating code that supports parallel algorithms is a way to significantly increase performance of an application on a multi-core platform. The results shown here demonstrate that performance gains are in linear proportion to the number of physical cores used. Note that parallel code is especially justified for cases in which large data sets are required. For the test case above, ConcRT demonstrates better performance than OpenMP. ConcRT is a new technology presented in Microsoft Visual Studio 10 and is tightly integrated with the development environment. The key point to remember is that applying parallel techniques on a multi-core platform provides significant benefits, especially for large data sets, and regardless of the specific technology used.

[1] Concurrency Runtime http://msdn.microsoft.com/en-us/library/dd504870.aspx
[2] OpenMP http://msdn.microsoft.com/en-us/magazine/cc163717.aspx

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