QuickhullDisk: a faster convex hull algorithm for disks. (English) Zbl 1433.52002


Summary: Convex hull is one of the most fundamental constructs in geometry and its construction has been extensively studied. There are many prior works on the convex hull of points. However, its counterpart for weighted points has not been sufficiently addressed despite important applications. Here, we present a simple and fast algorithm, QuickhullDisk, for the convex hull of a set of disks in $\mathbb{R}^2$ by generalizing the quickhull algorithm for points. Takes $O(n \log n)$ time on average and $O(mn)$ time in the worst case where $m$ represents the number of extreme disks which contribute to the boundary of the convex hull of $n$ disks. These time complexities are identical to those of the quickhull algorithm for points in $\mathbb{R}^2$. Experimental result shows that the proposed algorithm runs significantly faster than the $O(n \log n)$ time incremental algorithm, proposed by O. Devillers and M. J. Golin [Inf. Process. Lett. 56, No. 3, 157–164 (1995; Zbl 0875.68901)], particularly for big data. QuickhullDisk is approximately 2.6 times faster than the incremental algorithm for random disks and is 1.2 times faster even for the disk sets where all disks are extreme. This speed-up is because the basic geometric operation of the QuickhullDisk algorithm is a predicate for the location of a point w.r.t. a line and is much faster than that of the incremental algorithm. The source code of QuickhullDisk is freely available from Mendeley Data and a GUI-version from Voronoi Diagram Research Center, Hanyang University (http://voronoi.hanyang.ac.kr/).

MSC:

52-04 Software, source code, etc. for problems pertaining to convex and discrete geometry
68U05 Computer graphics; computational geometry (digital and algorithmic aspects)
52B55 Computational aspects related to convexity
65D18 Numerical aspects of computer graphics, image analysis, and computational geometry

Keywords:
weighted points; incremental algorithm; quicksort; quickhull; Voronoi diagram; divide and conquer

Software:
MinPerim; Quicksort; QuickhullDisk; Qhull

Full Text: DOI

References:


O'Rourke, J., Computational Geometry in C (1998), Cambridge University Press.


Seidel, R., A convex hull algorithm optimal for point sets in even dimensions (1981), University of British Columbia, Master thesis.


An, P. T., Method of orienting curves for determining the convex hull of a finite set of points in the plane, Optimization, 59, 2, 175-179 (2010).


Hubert, L.; Pocchiola, M., Computing the convex hull of disks using only their chirotope, Proceedings of the European Workshop on Computational Geometry [20TH EWC0G] (2004).


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