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Sweepline Algorithm for Voronoi Diagram of Polygonal Sites

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Abstract : Voronoi Diagram (VD) of finite set of disjoint simple polygons, called sites, is a partition of plane into loci (for each site at the locus) – regions, consisting of points that are closer to a given site than to all other. Set of polygons is a universal model for many applications in engineering, geoinformatics, design, computer vision, and graphics. VD of polygons construction usually done with a reduction to task of constructing VD of segments, for which there are effective O(n log n) algorithms for n segments. Preprocessing – constructing segments from polygons' sides, and postprocessing – polygon's loci construction by merging the loci of the sides of each polygon are also included in reduction. This approach doesn't take into account two specific properties of the resulting segment sites. Firstly, all this segments are connected in pairs in the vertices of the polygons. Secondly, on the one side of each segment lies the interior of the polygon. The polygon is obviously included in its locus. Using this properties in the algorithm for VD construction is a resource to reduce computations. The article proposes an algorithm for the direct construction of VD of polygonal sites. Algorithm is based on sweepline paradigm, allowing to effectively take into account these properties. The solution is performed based on reduction. Preprocessing is the constructing of set of sites from vertices and edges of polygons. Each site has an orientation such that the interior of the polygon lies to the left of it. Proposed algorithm constructs VD for set of oriented sites with sweepline paradigm. Postprocessing is a selecting of edges of this VD formed by the centers of empty circles touching different polygons. Improving the efficiency of the proposed sweepline algorithm in comparison with the general Fortune algorithm is achieved due to the following fundamental solutions: 1. Algorithm constructs only such VD edges, which are on the outside of polygons. Concept of oriented sites allowed to avoid construction of VD edges located inside the polygons. 2. The list of events in sweepline algorithm has a special property: the majority of events are connected with "medium" polygon vertices, where one incident polygon side lies behind the sweepline and the other in front of it. The proposed algorithm processes such events in constant time and not in logarithmic time, as in the general Fortune algorithm. The proposed algorithm is fully implemented and tested on a large number of examples. The high reliability and efficiency of the algorithm is also confirmed by computational experiments with complex sets of several thousand polygons. It should be noted that, despite the considerable time that has passed since the publication of Fortune's algorithm in 1986, a full-scale implementation of this algorithm for an arbitrary set of segment sites has not been made. The proposed algorithm fills this gap for an important special case - a set of sites formed by polygons.

Keywords : voronoi diagram, sweepline, polygon sites, fortunes' algorithm, segment sites
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