World Academy of Science, Engineering and Technology
International Journal of Mathematical and Computational Sciences
Vol:9, No:05, 2015

Triangulations via Iterated Largest Angle Bisection

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Abstract : A triangulation of a planar region is a partition of that region into triangles. In the finite element method, triangulations are often used as the grid underlying a computation. In order to be suitable as a finite element mesh, a triangulation must have well-shaped triangles, according to criteria that depend on the details of the particular problem. For instance, most methods require that all triangles be small and as close to the equilateral shape as possible. Stated differently, one wants to avoid having either thin or flat triangles in the triangulation. There are many triangulation procedures, a particular one being the one known as the longest edge bisection algorithm described below. Starting with a given triangle, locate the midpoint of the longest edge and join it to the opposite vertex of the triangle. Two smaller triangles are formed; apply the same bisection procedure to each of these triangles. Continuing in this manner after n steps one obtains a triangulation of the initial triangle into 2n smaller triangles. The longest edge algorithm was first considered in the late 70's. It was shown by various authors that this triangulation has the desirable properties for the finite element method: independently of the number of iterations the angles of these triangles cannot get too small; moreover, the size of the triangles decays exponentially. In the present paper we consider a related triangulation algorithm we refer to as the largest angle bisection procedure. As the name suggests, rather than bisecting the longest edge, at each step we bisect the largest angle. We study the properties of the resulting triangulation and prove that, while the general behavior resembles the one in the longest edge bisection algorithm, there are several notable differences as well.

Keywords : angle bisectors, geometry, triangulation, applied mathematics
Conference Title : ICAMEM 2015 : International Conference on Applied Mathematics and Engineering Mathematics
Conference Location : Istanbul, Türkiye
Conference Dates : May 21-22, 2015