Adaptive isotropic mesh generation with pre-specified element sizes

P.L. George
INRIA, Domaine de Voluceau, BP 105, Le Chesnay Cedex, France

Abstract

The generation of an adequate mesh is an essential pre-requisite in any finite element simulation of a physical phenomenon described in terms of PDE's. This paper discusses a method enabling to generate a three-dimensional mesh conforming a user-specified size map. This Delaunay-type method creates isotropic tetrahedral meshes conforming the specified size map. This adapted (governed) method is the natural extension of the classical mesh generation method described in [3]. This method proved to be especially suitable in mesh adaptation schemes whose main components include an automatic mesh generation method and a solution method coupled with an error estimate.

Note : The following materials include materials extracted from [2] and [1]. This course also assumes a good understanding of what a classical Delaunay mesh generation method is, see [3].

Introduction

An essential pre-requisite in the numerical finite element simulation of physical problems expressed in terms of PDE's is related to the construction of an initial adequate mesh of the domain. This first stage, usually involving any fully automatic mesh generation method, is then followed by a computational step. The numerical solution obtained with the initial mesh is generally analyzed via an error estimate, which will indicate whether or not the process has converged, based on the quality of the solution. The latter is closely related to the mesh ad-equation with the underlying physical phenomenon. Hence, the role of the error estimate is to indicate if the mesh density is too coarse or to fine in some regions. In the first case, the computational scheme is too time consuming, as in the other case, the solution behavior is probably not even captured. To match these requirements, an adapted mesh needs to be generated, its refinement been related to the above specifications.

We do not focus explicitly on the error estimate part, however we like to emphasize the meshing technology and, in the isotropic case, we propose a method enabling to create a mesh, such that, at the same time, the elements are as regular as possible and the element size corresponds to a pre-specified size (this data being supplied by the error estimate).

The proposed method is Delaunay-based. At first, we give the general framework in which the mesh generation problem is posed. For self-containing purposes, we recall the main features of this type of method as it is in the classical case, *e.g.* without any size map). After which, we mention several approaches used to define a size map in the