ADAPTATIVE METHOD FOR NUMERICAL SIMULATION OF FLUID FLOW BASED ON POINT CLOUDS & APPLICATIONS TO URBANS ENVIRONNEMENTS.

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The actual challenge of fluid flow simulation in urban environnements is to work from real datas, including the geometries. A first step in this direction is to be able to make calculations from a point cloud assumed to represent accurately the high level of detail of these soil geometries. Furthemore, flows are often turbulents with large Reynolds number [1] and a very thin mesh et small time step are needed. We propose in this paper a method which allows to simulate fluid flow in the context of urbans environnements thanks to finite element method coupled with a mesh adaptation procedure.

A principal component analysis is performed on every point of the cloud and his neighbourhood in order to build a metric field and a distance function [2]. The iso-zero of this distance function defines a level-set which represents the point-cloud discretized manifold. This level-set is also used in a procedure that adapts the mesh on a thinkness $\varepsilon>0$ around the iso-zero, to get a more useful mesh and thin enough to capture all the details of the geometrie [3]. Based on this level-set a Dirac function is also built, to impose the boundary conditions at nodes. Finally, we use the variational multi-scale method (VMS) to study the evolution of fluid flow as a function of time [4].

We'll validate the method by considering classical benchmark such as the flow past a cylinder or a square defined by a set of points. We'll also perform calculations on 3D point clouds self-acquired whose density is not uniform (such as the Stanford bunny and the Rue Madame in Paris). We'll discuss about the definition of the neighbourhood of a point used to compute the metric field. We'll also highlight the problems linked to the urbans environnements such as the undesirable objects or hard to acquire.

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