MODELIZATIONS OF MOVING OBJECT IN A FLUID FLOW USING LEVEL SET.

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Our group works on the development of a parallel adaptive discontinuous Galerkin code to solve engineering flow problem. In the present work we are interested in studying the influence of a moving object in the flow on the development of shocks structures. A particular interesting problem is the development and propagation of shocks structures around a cannon blast. From experimental data, it appears that the motion of the bullet in the flow influence the overall shocks structures. The bullet itself move at a speed close to the sound speed, but the exact flow around it does not seems of great importance to understand the shocks structures far from it. We are therefore investigating a technique to model the influence off the bullet without explicitly following its motion with the mesh, which would imply a lot of work spend in mesh modification so that the moving boundary conditions could be applied.

The level set method is more and more used to model moving interfaces in various applications [1] and seems to be the way to go since we are not interested by the exact resolution of the flow near the moving boundary. We define a level set function every where on the domain, which value is related to the distance to the boundary. The boundary of the object is then not explicitly defined, but for each point on the domain, a request to the level set function returns the distance to the boundary. We will describe how, from this information only and without explicitly reconstruct the position of the boundary, boundary conditions can be imposed as a flux on a strip in the neighborhood of the geometrical boundary, so that the contribution of this boundary can be computed on the element level, along with the usual volume contribution of each element.
In a three-dimensional case, a moving surface boundary condition is then replaced by the integration of a flux over the whole domain, for which only the contribution of the points inside a three-dimensional shell with a thickness ϵ surrounding the geometrical boundary are not null. We then show how this integration converge with ϵ to the exact boundary condition, upon some continuity constraint on the flux. The results demonstrate that the influence on the overall shocks structure is well captured even if some discrepancies appear near the boundary.

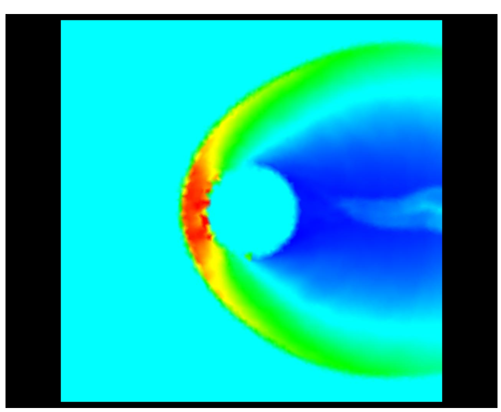

Figure 1: A Mach 3 flow around a cylinder defined by a level-set function

[1] J.A. Sethian, “ Level Set Methods and Fast Marching Methods Evolving Interfaces in Computational Geometry, Fluid Mechanics, Computer Vision, and Materials Science," *Cambridge Monograph on Applied and Computational Mathematics* , 1999.