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IDENTIFICATION OF THE UNKNOWN OBJECTS IMMERSED IN NAVIER-STOKES FLUID VIA LEVEL SET METHOD[a]

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Abstract. This paper presents a numerical method of the identification of objects immersed in an incompressible viscous flow governed by the stationary Navier-Stokes equations. The proposed method is based on a combination of the classical shape sensitivity analysis and the variational level set method. By this method, a relatively smooth evolution can be maintained without re-initialization and drastic topology change can be handled easily. Finally, two benchmark examples are provided in order to validate the theoretical analysis.

Keywords. Shape identification, navier-stokes problem, level set method, shape sensitivity analysis, inverse problems.

AMS (MOS) subject classification: 49Q10, 35Q30, 49K40.

1 Introduction

Shape identification or reconstruction is a branch of inverse problems, an area of applications in which the optimal control approach is a standard method [1, 2]. The optimal shape control of the fluid flow has long been a subject of interest to engineers and scientists and the applications are uncountable [3]-[10]. In this paper, we will concern ourselves with shape identification problem associated with flows governed by the stationary, incompressible Navier-Stokes equations.

The classical method of shape sensitivity, which has been much studied, is a very general method that can handle any type of objective functional and fluid models [11, 12]. But this method is implemented in a Lagrangian framework, remeshing process can not be avoided in most cases, hence it is very time-consuming [13].

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