Identification of Piecewise Constant Robin Coefficient for the Stokes Problem Using the Levenberg-Marquardt Method

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Abstract

Levenberg-Marquardt method (LMM) is a Newton type method used to solve nonlinear least squares problems. The LMM is widely used because of its simplicity and because it's known to have a quadratic rate of convergence under nonsingularity condition.

In this work, we have used the LM method in order to solve the inverse problem consisting on the reconstruction of the Robin coefficient on some non accessible part of the boundary of a domain governed by the Stokes system from measurements available on some accessible part. Such problem can model for example the study of the resistivity of a cerebral stent, or the study of the air- flow resistance that characterizes in pneumology the patient ventilation capability.

This ill-posed problem is initially formulated as a nonlinear and nonconvex minimization. The LM method trasform it into a convex one. Under some suitable hypothesis, we have proved the quadratic convergence of this method under the assumption that the Robin coefficient is piecewise constant on some part of the boundary on which the velocity of a given reference solution stays far from 0. We have used the surrogate functional technique to simplify the numerical procedure.

To prove the efficiency of our study, we have appplied the method with different choices of the geometry of the domain. First we have considered an annular domain, then an aneurysmal-type one and finally a one that symbolizes, in a simplifyed manner, some truncation of the bronchial tree.

The results obtained show that the method gives very good approximations of the true Robin coefficient values.