Regularization in model updating

B. Titurus and M. I. Friswell∗,†

Department of Aerospace Engineering, University of Bristol, Queen’s Building, University Walk,
Bristol BS8 1TR, U.K.

SUMMARY

This paper presents the theory of sensitivity-based model updating with a special focus on the properties of the solution that result from the combination of optimization of the response prediction with a priori information about the uncertain parameters. Model updating, together with the additional regularization criterion, is an optimization with two objective functions, and must be linearized to obtain the solution. Structured solutions are obtained, based on the generalized singular value decomposition (GSVD), and specific features of the parameter and response paths as the regularization parameter varies are explored. The four different types of spaces that arise in the solution are discussed together with the characteristics of the regularized solution families. These concepts are demonstrated on a simulated discrete example and on an experimental case study. Copyright © 2007 John Wiley & Sons, Ltd.

Received 25 May 2007; Revised 22 October 2007; Accepted 24 October 2007

KEY WORDS: sensitivity; model updating; non-linear regression; regularization; optimization; GSVD

1. INTRODUCTION

The goal of model updating is to improve a mathematical model of an existing structure using measurements performed on this structure. Model updating is an inverse problem, and a characteristic feature of inverse problems is that they may be ill posed. A problem is well posed [1] if its solution exists, is unique, and continuously depends on errors present in the problem formulation. If the problem fails to fulfill any of these conditions, then it is said to be ill posed. The existence and uniqueness are often assured by the introduction of additional assumptions, leading to some generalized solutions of the problem, such as the normal pseudosolution [2], i.e. a minimum norm solution. The solution stability, that is the dependence of the solution on perturbations in the data, can be violated even when the solution exists and is unique [3]. Research in this area has built on