

Assessment of Various Methods in Solving Inverse Heat Conduction Problems

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1. Introduction

In an inverse heat conduction problem (IHCP), the boundary conditions, initial conditions, or thermo-physical properties of material are not fully specified, and they are determined from measured internal temperature profiles. The challenge is that the effect of changes in boundary conditions are normally damped or lagged, i.e. the varying magnitude of the interior temperature profile lags behind the changes in boundary conditions and is generally of lesser magnitude. Therefore, such a problem would be a typically ill-posed and would normally be sensitive to the measurement errors. Also, in the uniqueness and stability of the solution are not generally guaranteed (Beck et al., 1985; Alifanov, 1995; Ozisik, 2000). Inverse heat conduction problems, like most of the inverse problems encountered in science and engineering may be reformulated as an optimization problem. Therefore, many available techniques of solving the optimization problems are available as methods of solving the IHCPs. However, the corresponding objective function of the inverse problems can be highly nonlinear or non-monotonic, may have a very complex form, or in many practical applications, its analytical expression may be unknown. The objective function usually involves the squared difference between measured and estimated unknown variables. If Y and T are the vectors of the measured and estimated temperatures, then the objective function will be in the form of

$$U = [Y - T]^T [Y - T] \quad (1)$$

However, normally there is need for another term, called "regularization" in order to eliminate the oscillations in the results and make the solution more stable. The effect of this term and the strategy of choosing it will be discussed in details in the subsequent chapters. The above equation is only valid, if the measured temperatures and the associated errors have the following statistical characteristics (Beck & Arnold, 1977):

- The errors are additive, i.e.

$$Y_i = T_i + \varepsilon_i \quad (2)$$

where ε_i is the random error associated with the i^{th} measurement.

- The temperature errors have zero mean.
- The errors have constant variance.

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Methods for Inverse Heat Conduction Problems Dinh Nho Hào, 1998 The problems of determining the surface temperature and the surface heat flux the capacity of the heat transfer coefficient from transient temperature measurements at one or more locations are frequently arising in many practical engineering contexts These so called inverse heat conduction problems IHCPs have been extensively studied over the last 30 years This book starts with an up to date overview on the subject It is mainly devoted to solvability criteria for IHCPs as well as efficient and stable solution methods like mollification methods variational and iterative methods

Traffic, Environment, Politics Joop Schopman, 2000 The advance of motorized traffic has brought our attention to its disadvantages Noise and exhaust gases do not just annoy people they threaten human health and welfare This book reports the scarcely available measurements of emissions to which adverse health effects are attributed From these data it appears that although hardly any particular health effect can be scientifically proven to be caused by road traffic combined these effects strongly indicate that public health is endangered and action should be taken The 1950 1980 efforts by the US government to formulate exhaust standards for cars are used to illustrate the political difficulties inherent in such undertaking

Das Schweizer Buch, 1998 **Deutsche Nationalbibliographie und Bibliographie der im Ausland erschienenen deutschsprachigen Veröffentlichungen**, 1996 **American Book Publishing Record**, 1998 *Subject Guide to Books in Print*, 1991 **German books in print**, 1995 **Verzeichnis lieferbarer Bücher**, 1999 **Numerical Methods for Inverse Heat Conduction Problems** Fredrik Berntsson, 2001 *Extreme Methods for Solving Ill-posed Problems with Applications to Inverse Heat Transfer Problems* Oleg Mikhaïlovich Alifanov, Evgeniï Alekseevich Artiukhin, Sergei Vladimirovich Rumiantsëv, 1995-01-01 This monograph is based on the author's studies carried out to investigate one of the most promising trends in the theory of ill posed problems namely iterative regularization and its application to inverse heat transfer problems Effective methods for solving inverse problems have allowed researchers to simplify experiments considerably and to increase the accuracy and confidence of results in experimental data processing The authors discuss a broad range of problems concerned with both the theory of regularizing gradient algorithms and peculiarities of their application to the most often encountered inverse problems of reconstruction of external heat fluxes and the identification of mathematical models for heat transfer processes

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