ESTIMATION OF DISTRIBUTED HEAT SOURCES
WITHIN TWO DIMENSIONAL SHAPED BODIES

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The inverse heat conduction problem (IHCP) which consists in the determination of unknown heat sources, spatially distributed within a body, is considered. The numerical solution of the problem is computed for two dimensional heat flow and arbitrary shaped bodies in transient regime, using the Conjugate Gradient Algorithm.

The method is based on the iterative solutions of three distinct parabolic equations in order to minimize a least square functional: a) the equations of the direct heat conduction problem, b) the equations of the adjoint problem, c) the sensitivity equations. The method is easily implemented using the Finite Element library MODULEF. Thanks to the meshing and graphic processors of the library, the method applies for computing the numerical solution of the IHCP in a wide field of thermal analysis, for bodies involving several distinct subdomains with imperfect thermal contact and complex shape. To illustrate the method, two numerical experiments are described.

In the first example, the spatial distribution and the time varying magnitude of the heat source are unknown but separate functions. The additional data required to solve the IHCP consists of over specified boundary conditions (heat flux and heat transfer coefficient are known) on some part of the boundary of the domain. Internal measurements can also be taken into account. The direct heat conduction problem is linear and the solution of the IHCP is linearly dependant of the additional data. In the second example, the unknown heat source is assumed to be dependant of the temperature, this assumption leads to slight modifications of the method. The direct and the inverse heat conduction problems are non linear. For both examples, influence of data errors on the computed solutions is examined, in order to illustrate the limit and the efficiency of the method.

Keywords: Inverse problems, inverse heat conduction, volume heat sources, conjugate gradient algorithm.