Multi-Dimensional Inverse Heat Conduction Solutions Using a "Black Box" Direct Solver

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The Inverse Heat Conduction Problem (IHCP) has been under investigation for over a half a century as a means of estimating surface heat flux from subsurface temperature measurements. Many environments produce a heat flux so severe that temperature sensors will not survive. Also, the presence of the temperature sensor on an exposed surface may alter the heat flux one is trying to measure. Consequently the sensor(s) often must be placed inside the body to insure their survivability.

The development of algorithms for solving the 3D IHCP has outpaced the development of practical codes for solving real world industrial problems. This article addresses the need for solving the 3-D IHCP with "black box" or commercial direct problem solvers for which source code modification is not an option. If the implementation of the IHCP algorithm is done through external file communication, new features added to the direct heat conduction solver are automatically available for the IHCP also.

This article presents the lessons learned during the development of an IHCP algorithm implemented with a “black box” direct solver. Emphasis is placed on methods for extracting the sensitivity coefficients from the direct solver. Case studies and numerical experiments representative of conditions experienced during a high energy laser engagement are presented.