"APPLICATION OF AN INVERSE METHOD TO THE DETERMINATION OF CONVECTIVE HEAT TRANSFER (APPLICATION TO IMPINGING JETS)"

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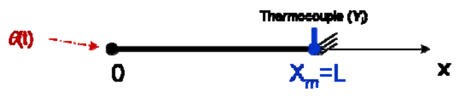
Research in heat transfer commonly involves experimentation or experiment design aimed at evaluating the boundary conditions required to find the solution of mathematical models. The resolution of the fundamental heat transfer equation, in order to calculate the temperature variations in time and space, constitutes what is usually called a *direct problem*.

However, in many industrial applications, the direct measurement of thermal quantities such as surface temperatures or heat fluxes proves to be unfeasible, either because a direct measurement could corrupt the wanted quantity or because the sensors would not survive an extremely severe environment. When one of the boundary conditions necessary to solve the direct problem is missing and is to be found, but some supplemental data are available from an experimental examination of the process, then we talk about an *inverse problem* (also known as *indirect problem*). Hence, an *inverse problem* consists in determining the heat flux and surface temperature at not accessible locations retrieving the information from experimental measurements taken on more reachable positions.

Inverse methods are based on the minimization, in the least square sense, of the error between the solution of the direct model for a guessed boundary condition and the measurements available at some specific location.

By its very nature, the *inverse problem* is likely to be an ill-posed problem; therefore, the quality of the experimental data is crucial, as the estimated solution is very sensitive to measurements errors. This is why a careful design of the experiment is a key point in the inverse methodology.



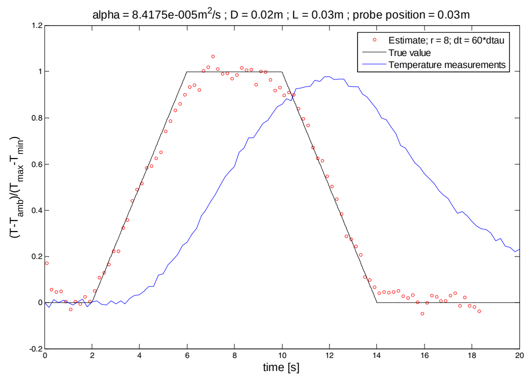


Figure 1: Inverse method applied to a 1D model. Above: sketch of the 1D system. Right: virtual measurement have been perturbed with artificial noise (blue solid line) and used as input for the inverse model. The estimated temperature history (red dots) is compared to the exact one (black solid line).

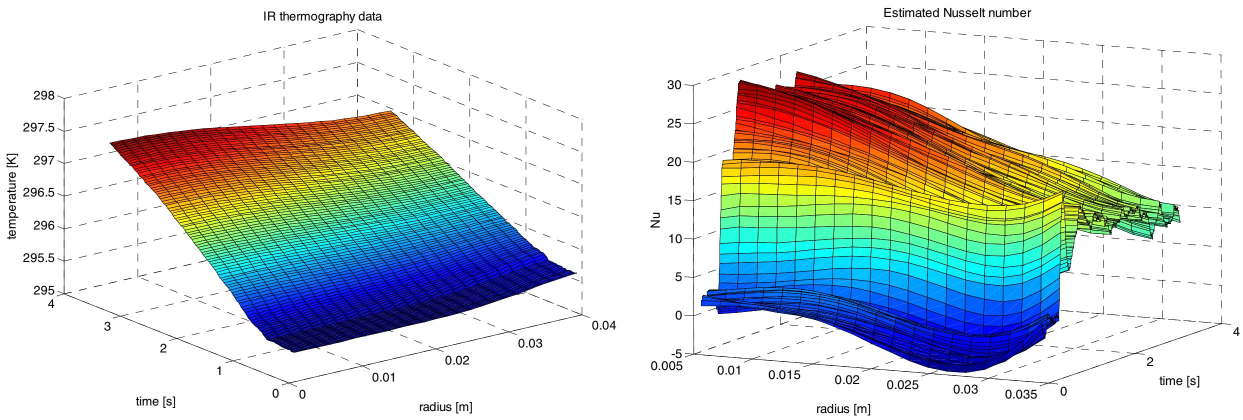


Figure 2: Inverse methodology applied to an impinging hot-air jet. Left: temperature measurement performed via IR camera along the radius of a circular plate. Right: Nusselt number evolution retrieved through inverse methodology on the opposite surface of the plate.