Abstract

Multisensor data fusion (MSDF) is a technique which combines data from multiple sources to extract unique features which cannot be achieved from a single sensor. Though MSDF finds many applications in the military and non-military fields, the application in thermo-fluids problems is relatively new and limited. The present dissertation focuses on the investigation of some heat transfer and fluid flow problems through the application of MSDF.

The first problem deals with the reconstruction of an internal hot spot in a two dimensional circular domain using Bayesian Inference Technique (BIT) and Markov Chain Monte Carlo sampling algorithm. A semi–analytical forward model based on the boundary collocation method is used to determine the temperature distribution. The reconstruction of the hotspot is done by estimating its location, size and temperature from synthetic and measured temperature data at the periphery. The parameters are estimated individually as well as in combinations. Sensitivity analysis is performed to check the predictability of the parameters.

Next, the reconstruction of an axi-symmetric moving void is attempted through two separate techniques using conductivity and optical sensors respectively. The predicted shape is compared with the refraction corrected image. In the first case, a calibration curve generated from the modelling of the electric field is used. In the other case, through BIT, the reconstructed bubble shape is obtained exploiting the deviation of the optical beam. The possible sources of error and their relative magnitudes are also discussed.

Finally, the identification and the characterisation of upward air-water flow are performed by processing of data from multiple sensors as well as high speed digital images. The data from a single conductivity probe and a multitudes of optical probes (two different arrangements) are used for the classification of the flow regimes. The same data are used to reveal non-linear dynamics of the flow through recurrence plots. In a separate effort, the flow phenomena are also classified through an intensity based image analysis incorporating time history and spatio-temporal plots. Multiple features of the digital images are used to characterise the bubbly flow in a comprehensive manner.