CAT FOR 3D FIELD RECONSTRUCTION

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The line-of sight techniques based on transmitting a light wave through the fluid flow are traditionally used for the flow visualisation. The main problem of such techniques is that they give the integrated information on the refractive index along the path of the light [1,2]. The general way to obtain quantitative interior flow information is to use multidirectional line- of- sight measurements and to reconstruct the 3D data using computer aided tomography (CAT). In this case, the 3D distribution of the fluid density can be resolved by recording with the optical setup several projections in different directions through the flow and processing the obtained data with the methods of computer tomography. For a given test object, the quality of the tomographic reconstruction depends on the number of projections taken, the covered total angular range of viewing directions, and the amount of information available from each projection [3,4].

Classical techniques, such as shadowgraphy, interferometry or absorption, as well as speckle photography, allow the three dimensional distributions of physical observables to be reconstructed using images of the flow taken at different directions. If the flow has rotational symmetry, one projection only is sufficient, and the axisymmetrically distributed fluid density can be determined by applying the Abel inversion. In the general case, the integral Radon transformation can be used for the data obtained from either laminar or turbulent flow, but an exact determination of the interior flow parameter distributions would need an infinite number of projections. Because of the finite number of projection measurements available the application of the Radon transformation becomes an ill-posed mathematical problem. In practice this means that a small inaccuracy in the experimental data can lead to significantly large errors in the final flow parameter determination.

Several mathematical algorithms are available for reconstructing the 3D field from the information recorded in various projections with the convolution back projection method being the most widely used. In the present work an iteration technique has been adopted for the calculation of the Radon integral. This approach has been refined to accommodate information about the sought distribution as the first approximation. The details of the technique as well as some examples of reconstructing the local parameters of combined flows from the data of limited-projection integral measurements with the use of the inverse Radon transform are given in [4-7]. The errors of such a reconstruction have been computed and analyzed. It has been shown that reconstruction of only relatively simple flows with a comparatively low asymmetry is possible when the number of projections is no larger than four.

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