IMPROVED NUMERICAL AND EXPERIMENTAL DATA POST PROCESSING FOR AEROACOUSTIC

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The measurement and simulation of the noise sources induced by flow has became increasingly important in aeroacoustic for the development of noise treatment techniques. Knowledge of the detailed sound production mechanism and location gives possibility to develop effective noise control methods. The large amount of data provided by the numerical and experimental investigations requires new, advanced post-processing techniques to point out the details of sound generation.
The scope of the present thesis composed of two parts. One of them is related to numerical aeroacoustic activities at the Department of Fluid Mechanics of BUTE. Noise source simulations of simple flow configurations like co-rotating vortex pair and annular jet mixing layer are performed and the source mechanism is studied. The recent results are summarized in the journal paper titled "Vortex Tracking as a tool for instantaneous Vortex Sound post-processing " currently is under submission to Journal of Sound and Vibration.

The other part is an experimental work on beam forming technique implemented in the VKI. The investigation is focusing on advanced beamforming algorithms of microphone array data. Source localization with improved resolution and quantitative source information can be obtained. The Generalised Inverse Beamforming (GIBF) algorithm is implemented with L_1 and L_2 norm regularization methods. The first tests showed exceptional resolution for the L1 norm Iteratively Reweighted solution procedure and it is also showed the possibility to reconstruct quantitatively the source amplitudes. The improvement of L_1 compared to L_2 norm is illustrated in Figure 1-2. However it is found to be difficult to determine the optimal regularization parameter for the algorithm. Studies on the L-curve method is done to assess the applicability to the L_1 norm solution procedure and to show the robustness of the algorithm against measurement noise found especially in non ideal acoustic environments. Publication of the results is currently in progress.

The microphone array instrumentation developed in the VKI is used to perform test measurements with the VKI semi-anechoic room and jet facility. A critical factor in the procedure is to measure the microphones position, required for the beam forming algorithm. The recently implemented algorithm based on multidimensional scaling and Levenberg-Marquardt nonlinear least squares is used to measure acoustically the positions of the constructed measurement array. The algorithm determines the relative microphones position coordinates by minimum of 5 separate measurements with a loudspeaker, and requires only the speed of sound as input parameter. The results found reliable enough to perform aeroacoustic measurement on the jet airfoil configuration.

Additionally microphone calibration techniques are further developed for fast calibration of several microphones in an acoustics impedance tube. Calibration of cheap electret microphones with good repeatability is possible on the current facility up to 4kHz. Advanced calibration methodology for many microphones in one step (even for 64 microphones) is developed based on wave pattern measurements in the impedance tube.

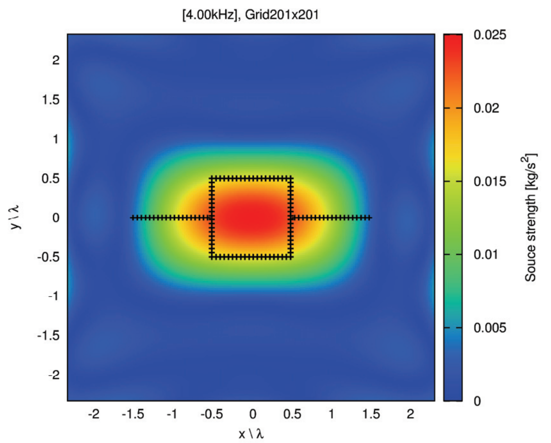

Figure 1: GIBF L2 norm reconstruction of the true sources denoted by black crosses (32 microphones)

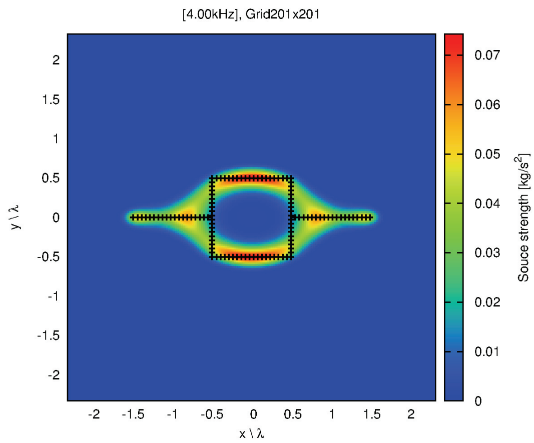

Figure 2: GIBF L1 norm reconstruction of the true sources denoted by black crosses (32 microphones)