Unsteady flow feature extraction of flapping events

A. Corrochano[*], R. Abadía-Heredia[*], M. Crialesi-Esposito [†],
L. Brandt[†] and S. Le Clainche[*]

Mixing layers formed by a gas and a liquid are common in industrial applications and natural phenomena, as in the mixing of a liquid fuel on a combustion engine, or in the waves on the ocean. A high velocity air stream jet injected simultaneously with a low velocity liquid jet generates a Kelvin-Helmholtz instability on the gas-liquid interface. This instability contributes to the liquid break-up, causing the formation of droplets.

It is shown in other studies[1] that the propagation speed of the interfacial wave is well predicted by the Dimotakis speed and the frequency related to that speed. However, recent studies[2] show that this frequency may not be accurate for the flapping events, which generate the greatest number of droplets. These events occur in larger time intervals, so the frequency related must be smaller.

In the present work, we analyse a database describing a Direct Numerical Simulation (DNS) of this problem. A representative snapshot of this simulation is presented in Fig.1. The database is composed by the three components of the velocity and the Volume of Fluid (VOF) field. The analysis has been carried out by means of Higher Order Dynamic Mode Decomposition (HODMD)[3], which decomposes the data into a Fourier-like expansion of modes, each one related to a frequency. In the analysis, we have been able to identify the frequency related to the Dimotakis speed, which describes the movement of the interface, and other frequency which is related to the flapping events. The identification of the two different modes gives potential for future flow control applications, enhancing or suppressing the formation of bubbles.

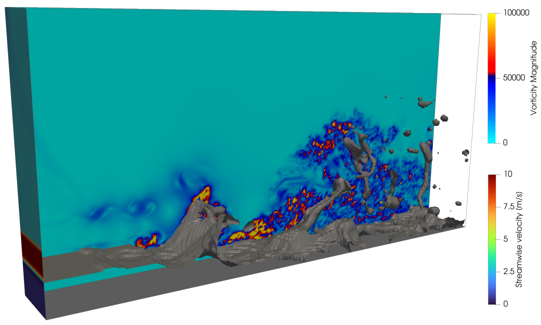

Figure 1: Representative snapshot of the simulation. In grey, the interface between the liquid and the air. Solid planes represent the walls. The inlet velocity profile is represented in the spanwise-normal plane and the magnitude of the vorticity is plotted in the streamwise-normal plane.

[*]E.T.S.I. Aeronáutica y del Espacio,Universidad Politécnica de Madrid, Spain
[†]Department of Engineering Mechanics, Royal Institute of Technology (KTH), Stockholm, Sweden
[1]Ling et al., *J. Fluid Mech.* **859**, 268–307 (2019).
[2]Crialesi-Esposito et al., *ICLASS Edinburgh* **1**, 1 (2021).
[3]Le Clainche and Vega, *SIAM J. Appl. Dyn.* **16**, 2 (2017).