Institute of Fluid Mechanics
and Environmental Physics
in Civil Engineering

Interdisciplinary project - Numerical modeling of bubble growth and detachment using geometric VOF method

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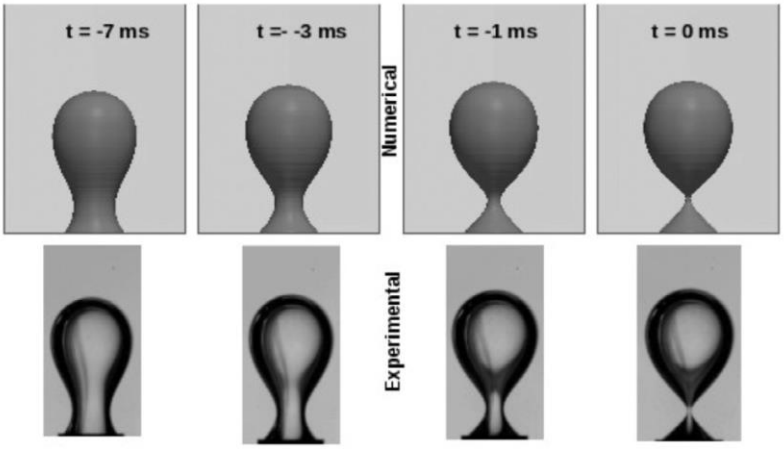

Figure 1: comparison between the experimental (Quan & Hua, 2008) and the numerical (Georgoulas et al., 2015) results for bubble detachment.

Description
Due to its relevance in various applications, bubble growth and detachment have attracted significant attention. This study focuses on modelling bubbles injected from an orifice with a specified diameter into a surrounding fluid. Accurately capturing the dynamics of bubble formation, detachment, and the resulting bubble size presents a considerable challenge. Additionally, modelling the movement of the bubble after detachment is also complex and difficult to predict.

Simulations of bubble detachment will be conducted using OpenFOAM software, and the results will be compared with results from the literature. The two-phase flow will be modelled using the geometric VOF (Volume of Fluid) method, which has been widely applied in previous numerical studies for this type of problem. However, in this work, we aim to use a specific method, called 'Grad Alpha method' (Scheufler & Roenby, 2021) for interface capturing and a specific method called 'Fit Paraboloid method' (Scheufler & Roenby, 2021) for curvature calculations.

Objective
2D simulations of bubble detachment from an orifice. Depending on the student's interest, the study could be extended to 3D simulations as well.

Main tasks
1. Literature review.
2. A Hands-on Introduction to Engineering Simulations using open source CFD software (OpenFOAM).
3. Setup of the cases.
4. Convergence analysis.
5. Analysis and interpretation of the results.

6. Comparison with the experiential and numerical results from literature.
7. Writing of the thesis.

Requirements

- Background knowledge - Numerical methods in fluid mechanics.
- Basic programming knowledge.
- Motivation and ability to work independently.
- English is the working language for this work.

Contact Information

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References:

1) Albadawi, A., Donoghue, D. B., Robinson, A. J., Murray, D. B., & Delauré, Y. M. C. (2013). On the analysis of bubble growth and detachment at low capillary and bond numbers using volume of fluid and level set methods. Chemical Engineering Science, 90, 77-91.
2) Georgoulas, A., Koukouvinis, P., Gavaises, M., & Marengo, M. (2015). Numerical investigation of quasi-static bubble growth and detachment from submerged orifices in isothermal liquid pools: The effect of varying fluid properties and gravity levels. International Journal of Multiphase Flow, 74, 59-78.
3) Scheufler, H., & Roenby, J. (2021). TwoPhaseFlow: An OpenFOAM based framework for development of two phase flow solvers. arXiv preprint arXiv:2103.00870.
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