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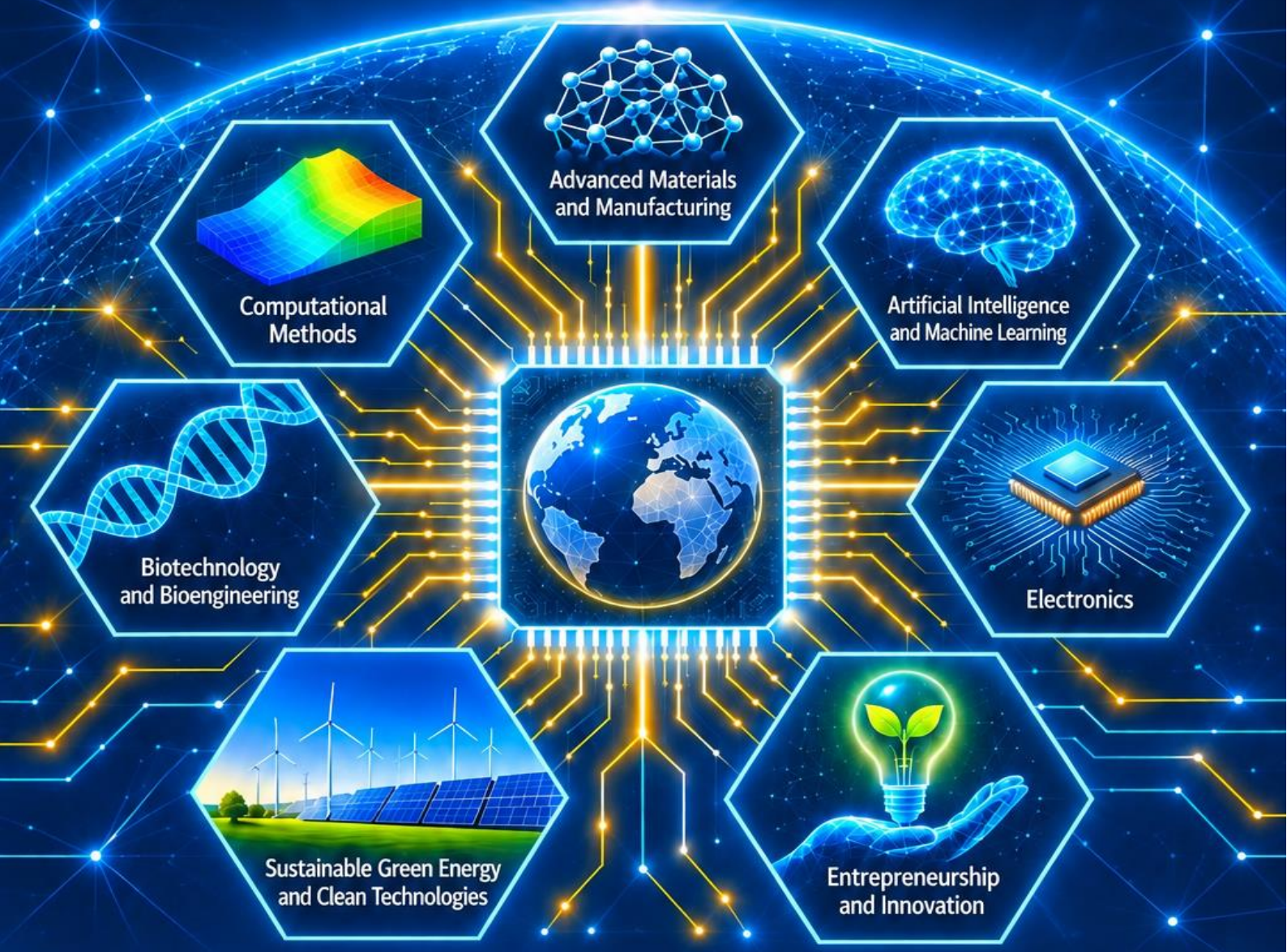
DeepTech Connect 2026

INTERNATIONAL CONFERENCE



CONFERENCE PROCEEDINGS



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April 24, 2026

DEEPTECH CONNECT 2026

The First DeepTech Connect International Conference 2026

April 24, 2026

Kragujevac, Serbia, Dublin, Ireland, Ioannina, Greece, Tours, France, Bergamo, Italy, Mondragon, Spain, Zvornik, Bosnia and Herzegovina, Gebze, Turkey

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DeepTech CONNECT

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PREFACE

The **FIRST DEEPTECH CONNECT INTERNATIONAL CONFERENCE 2026** was established as an international platform for presenting scientific research, showcasing technological innovations, connecting academia with industry, and promoting the transformation of research results into practical applications and market-oriented innovations. Building on the concept of research fairs and scientific exhibitions, the Conference provides an opportunity for researchers, students, companies, entrepreneurs and other innovation ecosystem stakeholders to exchange knowledge, demonstrate new technologies, establish partnerships and explore opportunities for scientific and technological cooperation.

Deep Tech encompasses advanced scientific and technological developments with the potential to generate significant breakthroughs and address major societal, environmental and industrial challenges. The Conference brings together interdisciplinary research and innovation across seven major thematic areas:

- **Advanced Materials and Manufacturing**, covering advanced and functional materials, additive manufacturing, architected materials, smart materials, mechanical behaviour, manufacturing processes, tribology, surface engineering, structural monitoring and sustainable manufacturing.
- **Artificial Intelligence and Machine Learning**, including machine learning algorithms, explainable AI, deep learning, computer vision, image processing, natural language processing, speech recognition, generative AI and AI applications in healthcare, engineering, manufacturing, energy and environmental systems.
- **Computational Methods**, encompassing numerical modelling, finite element analysis, computational simulation, engineering design optimization, manufacturing process modelling, structural and biomechanical simulation, virtual twins and advanced mathematical methods.
- **Biotechnology and Bioengineering**, including biological resources, food biotechnology, biomaterials, polymeric scaffolds, tissue engineering, engineered living materials, molecular and cellular research, biomedical instrumentation, healthcare technologies and rehabilitation.
- **Electronics**, addressing electronic circuit design, antennas, embedded systems, sensors, digital communications, wireless networking, Internet of Things (IoT), vehicle-to-everything (V2X) communications and cybersecurity.
- **Sustainable Green Energy and Clean Technologies**, covering waste management, circular economy, resource recovery, bioenergy, hydrogen production, energy efficiency, sustainable buildings, environmental monitoring, renewable energy, solar technologies, sustainable materials and digital energy systems.
- **Entrepreneurship and Innovation**, focusing on deep-tech entrepreneurship, start-up development, innovation ecosystems, technology transfer, knowledge valorisation, university–industry cooperation, management, education and skills development, green and social innovation, and digital and cultural innovation.

The scientific programme reflects the increasingly interdisciplinary nature of contemporary research, where advanced materials, computational methods, artificial intelligence, biotechnology, electronics and sustainable technologies contribute to the development of new products, processes and services.

Particular attention is given to the connections between scientific discovery, technological development, industrial applications and the commercialisation of research results.

The **First DeepTech Connect International Conference 2026** was held on **April 24, 2026**, simultaneously at eight university locations across Europe: University of Kragujevac (Serbia), Dublin City University (Ireland), University of Tours (France), Mondragon University (Spain), University of Ioannina (Greece), University of East Sarajevo (Bosnia and Herzegovina), Gebze Technical University (Türkiye) and University of Bergamo (Italy). This multi-location concept enabled participants to attend in person at their respective universities while connecting with researchers, students, companies and other participants across all locations through online networking. The simultaneous organisation of the Conference created an international environment for exchanging research capacities, identifying complementary expertise and initiating cross-border academic and industrial cooperation.

A distinctive feature of DeepTech Connect 2026 was its **research fair and exhibition format**. Instead of relying exclusively on conventional oral presentations, the Conference encouraged the presentation of scientific and technological contributions through physical exhibits, prototypes, experimental models, posters, computer simulations and interactive demonstrations. This approach provided opportunities for direct engagement with research results, enabling visitors to discuss scientific challenges, explore practical applications and interact with the researchers behind the innovations.

The Conference proceedings bring together contributions covering a broad spectrum of scientific disciplines and innovation activities. The **Advanced Materials and Manufacturing** section presents research on additive manufacturing, shape-memory materials, functional ceramics, structural design, manufacturing processes, tribology, coatings, sensing and monitoring, and engineering applications. The **Artificial Intelligence and Machine Learning** section demonstrates the growing role of intelligent computational approaches in prediction, image analysis, speech and language processing, healthcare, industrial systems, environmental monitoring and smart applications. Complementing these developments, the **Computational Methods** section addresses numerical and analytical modelling, finite element analysis, manufacturing simulation, engineering optimization, structural dynamics and virtual twin technologies. The proceedings also highlight the contribution of biological and medical sciences to technological innovation. The **Biotechnology and Bioengineering** section includes research on natural biological resources, food applications, biomaterials, polymeric scaffolds for bone regeneration, tissue engineering, engineered living materials, molecular biomarkers, biomedical instrumentation, cancer care and rehabilitation. The **Electronics** section presents developments in antennas, electronic circuits, embedded sensing, digital communications, wireless positioning, connected vehicles and automotive cybersecurity. In response to the increasing importance of environmental responsibility and the transition towards sustainable economic and industrial systems, the **Sustainable Green Energy and Clean Technologies** section addresses waste management, circular resource utilisation, bioenergy, hydrogen production, energy-efficient buildings, geothermal systems, environmental monitoring, solar energy, protective coatings and digitally enabled energy

communities. These contributions demonstrate how technological innovation, resource efficiency and digital solutions can support the development of more sustainable energy and environmental systems.
Beyond scientific and technological developments, the Conference recognises the importance of creating effective pathways for translating research into innovation and economic and societal value. The **Entrepreneurship and Innovation** section therefore addresses deep-tech enterprise development, entrepreneurial opportunities, prototyping, technology transfer offices, university–industry cooperation, innovation ecosystems, business competitiveness, project management, education and workforce development, green entrepreneurship, ESG approaches and user-driven, digital and cultural innovation. This section reinforces the importance of connecting research excellence with entrepreneurial capabilities, industrial needs and the wider innovation ecosystem.

An important objective of the Conference was to promote research careers and doctoral education by bringing students and young researchers into direct contact with experienced scientists, research groups, companies and innovation ecosystem representatives. The event provided opportunities to explore research topics, identify potential PhD supervisors and collaborators, learn about emerging technologies and better understand the opportunities associated with scientific and technological development.

International networking was an integral part of the Conference concept. Participants were encouraged to use the dedicated Conference web application, https://dtc.lineupr.com/dtc/ to connect with other attendees before and during the event, exchange information about their research interests and identify potential partners across the participating universities. This digital networking dimension complemented the physical exhibitions and enabled interaction beyond geographical and institutional boundaries.

The Conference was organised within the framework of the **A-SIDE project**, supported by the European Institute of Innovation and Technology (EIT) Higher Education Initiative. It contributed to the broader objectives of strengthening innovation and entrepreneurial capacity in higher education institutions, promoting knowledge valorisation, fostering university–industry cooperation and supporting the development of regional and international innovation ecosystems.

The **Conference Proceedings** provide a multidisciplinary overview of the research, technological developments and innovation activities presented at DeepTech Connect 2026. The contributions demonstrate the diversity of contemporary research, from fundamental scientific investigations and computational approaches to experimental developments, engineering applications, biomedical solutions, sustainable technologies and innovation-oriented business and educational models. Their thematic organisation also highlights important connections between the different fields, demonstrating how advanced materials and manufacturing, computational methods and artificial intelligence can support technological development, while biotechnology, electronics and sustainable energy provide pathways towards practical applications and solutions to societal challenges.

The First DeepTech Connect International Conference 2026 represents an important step towards establishing a sustainable international platform for connecting science, technology, education, entrepreneurship and industry. Its distinctive multi-university format and exhibition-oriented approach demonstrate the value of bringing research closer to students, companies and society, while creating opportunities for new partnerships, interdisciplinary cooperation and the commercialisation of deep-tech innovations.

The Conference was highly successful, attracting a large number of young people, early-career researchers, aspiring researchers, and PhD students. The scientific research fair format demonstrated that this innovative approach to presenting scientific work was very well received by young participants, who remained actively engaged throughout the Conference.

We hope that this publication will inspire further scientific research, encourage international and interdisciplinary collaborations, strengthen connections between academia and industry, and contribute to transforming scientific knowledge into innovative solutions with meaningful economic, environmental and societal impact.

Kragujevac, Serbia, 2026

Conference General Chair
Prof. Dr. Fatima Zivic
Faculty of Engineering
University of Kragujevac, Serbia

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Comparative Numerical Study of Two Interface-Capturing Methods for a Rising Bubble Problem

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Abstract

This paper presents a comparative numerical analysis of two interface-capturing methods, the Phase-Field and Level-Set method, applied to a rising bubble problem with subsequent interaction with an overlying fluid layer. The simulations are performed using the Finite Element Analysis. The bubble motion is evaluated through the evolution of its centroid and rise velocity prior to coalescence with the upper fluid layer. A Mesh sensitivity analysis is conducted for both methods. The results for both methods are presented comparatively through fluid interface snapshots at multiple time steps, as well as bubble centroid position–time and velocity–time curves. The results indicate that both methods capture the overall bubble rise behavior consistently, with a minor difference primarily related to discretization sensitivity and parameter selection.

Keywords: two-phase flow, bubble dynamics, phase-field method, level-set method, finite element method, UN SDG 9

1. Introduction

Multiphase flow phenomena are widespread in the environment, considering natural phenomena such as rain, snow, fog, biological and medical flows etc. They are also encountered in a wide range of engineering applications, including chemical reactors, oil and gas transport, heat exchangers, and microfluidic systems [1, 2]. In these systems, the dynamics of interfaces between immiscible fluids are essential in influencing overall transport processes, including momentum, mass, and heat transfer. Due to the shortcomings of theoretical, analytical, approaches and high costs of experimental tests, numerical methods have become essential tools for the analysis of multiphase flows [3]. The rising bubble problem represents a classical benchmark for studying interfacial dynamics, including deformation, buoyancy-driven motion, and interaction with surrounding fluid layers [4]. Among various approaches, interface-capturing methods have gained significant attention because of their ability to handle large deformations and topological changes, such as merging and breakup. The Level-Set method [5] represents the numerical technique for tracking moving interfaces and shapes by representing them as the zero-level set of a higher-dimensional implicit function, while the Phase-Field method [6], based

on diffuse-interface theory describes the interface using a continuous order parameter using the Cahn–Hilliard equation [7].

In this paper, a comparative numerical analysis of the Phase-Field and Level-Set methods for a rising bubble problem [4] with subsequent interaction with an overlying fluid layer is given. The bubble motion is evaluated through centroid position and rise velocity prior to merging with upper layer of fluid. This paper gives the systematic comparison of both methods within a Finite Element framework, highlighting their relative accuracy, sensitivity to mesh size, and practical applicability for problems involving interface deformation and merging.

2. Governing equations and numerical formulation

The fluid interface for two phase flow in this paper is captured using the Phase-Field and Level-Set formulations. For both interface capturing methods, the two-phase incompressible flow is described using the Navier–Stokes equations with an additional body force term accounting for surface tension effects at the fluid interface:

$$\rho\left(\frac{\partial \mathbf{u}}{\partial t}+\mathbf{u}\cdot\nabla\mathbf{u}\right)=-\nabla p+\nabla\cdot(2\mu\mathbf{D})+\rho\mathbf{g}+\mathbf{F}_{\sigma}, \tag{2.1}$$

$$\nabla\cdot\mathbf{u}=0\ , \tag{2.2}$$

Where $\boldsymbol{u}$ is the velocity vector, p is the pressure, ρ is the density, μ is the dynamic viscosity, $\mathbf{D}$ is the rate-of-strain tensor, and $\mathbf{F}_{\sigma}$ represents the surface tension force.

2.1 Phase-Field method

In the Phase-Field approach, the interface is described using a continuous order parameter ϕ, governed by the Cahn–Hilliard equation:

$$\frac{\partial\phi}{\partial t}+\mathbf{u}\cdot\nabla\phi=\nabla\cdot(M\nabla\mu) \tag{2.3}$$

where M represents, while the chemical potential μ is defined as:

$$\mu=\phi(\phi^2-1)-\varepsilon^2\nabla^2\phi \tag{2.4}$$

where ε represent the interface thickness parameter.

The surface tension force F_{σ} is derived from the free energy formulation:

$$\mathbf{F}_{\sigma}=\frac{3\sqrt{2}}{4}\frac{\sigma}{\varepsilon}\mu\nabla\phi \tag{2.5}$$

2.2 Level-Set method

The Level-Set method represents the interface implicitly through a scalar function ψ, whose transport is governed by:

$$\frac{\partial \psi}{\partial t} + \mathbf{u} \cdot \nabla \psi = \gamma \nabla \cdot \left(\varepsilon \nabla \psi - \psi(1-\psi) \frac{\nabla \psi}{|\nabla \psi|} \right) \tag{2.6}$$

The Surface tension is modeled using a curvature-dependent body force:

$$\mathbf{F}_\sigma = \sigma \kappa \nabla \psi, \qquad \kappa = \nabla \cdot \left(\frac{\nabla \psi}{|\nabla \psi|} \right) \tag{2.7}$$

where σ is the surface tension coefficient, κ is the interface curvature.

3. Numerical model

The two-phase flow problem considered in this paper is based on a benchmark example from the literature [4]. The computational domain is a cylinder with a height of 15 mm and diameter of 10 mm. Cross-section of computational domain with boundary conditions is shown in **Figure 21**a. At the initial position, two immiscible fluids are present: water occupying the lower region and oil forming a horizontal layer at the top of the domain. An oil bubble is initially positioned within the lower fluid, below the interface of two fluids. The initial bubble diameter is 4 mm, and its center is placed radially coincident with the center of the cylinder, and at a depth of 6 mm below the interface of the two fluids. The initial velocity field is set to zero throughout the domain. The flow is driven by buoyancy forces arising from density differences between the two fluids, while surface tension governs the interface deformation. The numerical model is developed using two-dimensional axisymmetric representation of a cylindrical domain (**Figure 21**b).

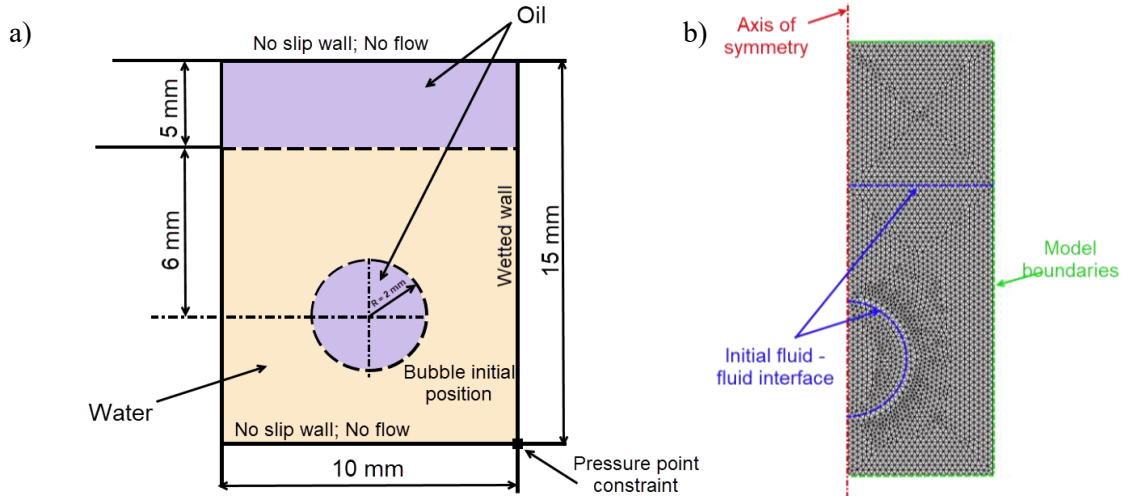

Figure 21 *a) Schematic representation of the computational domain, initial bubble position, and boundary conditions; b) Finite element model*

The left boundary on the FE model shown in **Figure 21**b corresponds to the axis of symmetry. No-slip boundary conditions are imposed on the bottom and top walls. A pressure point constraint is applied at a single point on the bottom boundary to ensure a unique pressure field. Wetted wall condition is prescribed on the vertical boundary on the right, allowing for consistent modeling of contact between the interface and the wall. The physical properties of both fluids are taken as constant, with density and viscosity defined for each phase corresponding to oil and water. The simulations are performed using both the Level-Set and Phase-Field

formulations within a Finite Element framework. A mesh sensitivity study is conducted using different characteristic element sizes (0.1 mm, 0.2 mm, and 0.3 mm) in order to assess the influence of spatial discretization on the predicted bubble dynamics. Time-dependent simulations are performed using an implicit time integration scheme, with maximum time step size 1e-4 in order to ensure numerical stability and accurate resolution of the interface evolution.

4. Results

Results are given for both interface capturing methods in form of interface evolution snapshots, bubble centroid evolution diagram and bubble rise velocity diagram.

4.1 Interface evolution

The evolution of the fluid interface is analyzed through a series of snapshots obtained at selected time instances (t_1 = 0.06 s, t_2 = 0.13 s, t_3 = 0.17 s and t_4 = 0.25. s). Snapshots illustrate the buoyancy-driven rise of the bubble, its deformation, and its subsequent interaction with the upper fluid layer. The interface evolution for Phase-Field method is shown in **Figure 22**.

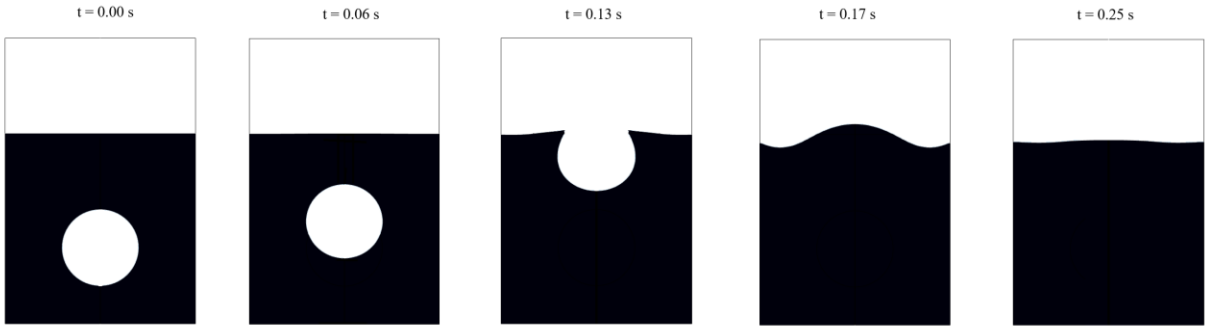

Figure 22 *The interface evolution for the Phase-Field method at times a) t_1 = 0.06 s; b) t_2 = 0.13 s, c) t_3 = 0.17 s and d) t_4 = 0.25 s*

The interface evolution for Level-Set method is shown in **Figure 23**. Snapshots are taken at the same time instances as for Phase-Field method.

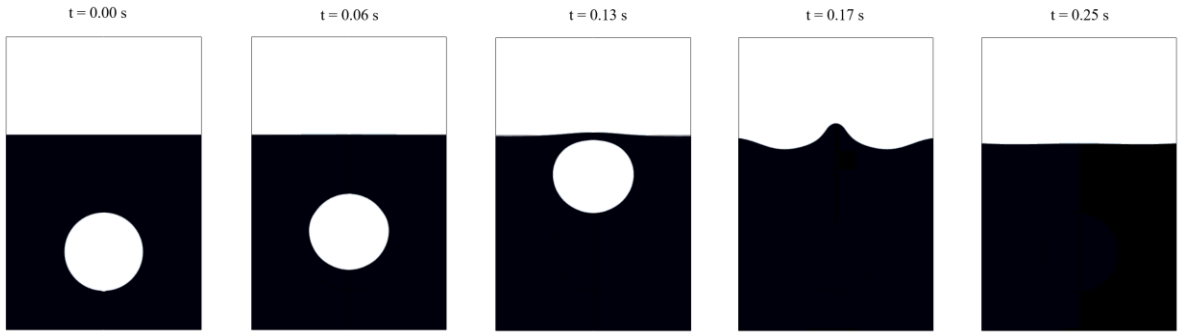

Figure 23 *The interface evolution for the Level-Set method at times a) t_1 = 0.06 s; b) t_2 = 0.13 s, c) t_3 = 0.17 s and d) t_4 = 0.25 s*

A comparison of interfaces between the two methods indicates that both approaches capture the overall interface evolution consistently. However, minor differences can be observed in the interface sharpness and deformation patterns near the merging stage, particularly in the vicinity of the upper fluid layer. Also, phase-field method predicts slightly higher velocities compared to the Level-Set method, i.e. bubble merges slightly earlier with upper fluid layer.

4.2 Mesh sensitivity

A mesh sensitivity study is conducted to evaluate the influence of spatial discretization on the numerical results. The vertical position of the bubble centroid is shown for mesh sizes of 0.1 mm, 0.2 mm and 0.3 mm for both methods (**Figure 24**).

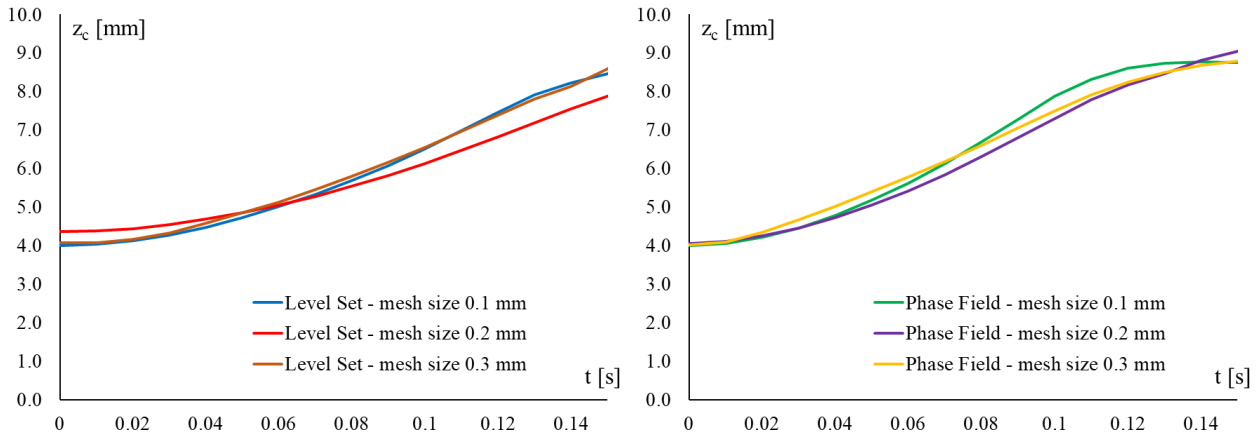

Figure 24 *Bubble vertical centroid position – time diagram for different mesh sizes for a) Level-Set method and b) Phase-Field method*

The results show a consistent trend in bubble centroid evolution across different mesh sizes prior to coalescence with the upper fluid layer. The Phase-Field method predicts slightly higher bubble rise velocities and centroid positions compared to the Level-Set method. For the Phase-Field formulation, the smallest mesh size results in a higher bubble position in the initial stage, which can be attributed to the diffuse interface representation. It should be noted that the observed differences are influenced not only by mesh resolution but also by the adjustment of interface-related model parameters, which may contribute to the deviations, particularly for the 0.2 mm mesh.

The comparison of the evolution of the bubble centroid vertical position for both methods is shown in **Figure 25**.

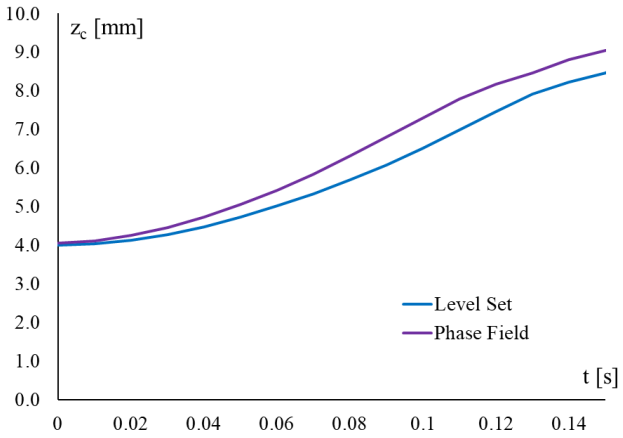

Figure 25 *Bubble vertical centroid position – time diagram comparison*

5. Discussion

Both methods show very realistic behavior, however, they cannot be experimentally verified as such testing would require a construction of complex setup and procurement of expensive monitoring equipment, and there is no existing experimental dataset in the scientific literature. The diffuse nature of the Phase-Field interface means surface tension is distributed over a finite width controlled by the parameter ε, while the Level-Set curvature is more sharply localized. This can lead to subtle differences in the effective surface tension force near coalescence, and consequently the difference in the rising velocity.

6. Conclusions

In this paper the Level-Set and Phase-Field are used to simulate a rising bubble problem with the coalescence with the upper fluid layer. A mesh sensitivity analysis is conducted for both methods, and the results show that both methods capture the overall bubble rise behavior realistically, with a minor difference primarily related to discretization sensitivity and parameter selection, with main conclusion summarized as:

- The Phase-Field method shows slightly higher predicted velocities, due to the differences in interface representation and parameter sensitivity near coalescence.
- Both methods show the trend of faster predicted rise with finer meshes.

The future work will feature a full 3D simulation of benchmark models, and studies of real-life problems with practical implications.

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