The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5-9 June 2022, Oslo, Norway

A reformulation of the level set equation with built-in redistancing

M. Fricke[1,*], T. Marić[2], A. Vučković[3] and D. Bothe[4]

[1,2,3,4]Institute for Mathematical Modeling and Analysis, TU Darmstadt,
Alarich-Weiss-Straße 10, 64287 Darmstadt, Germany,
https://www.mma.tu-darmstadt.de/
[1]fricke@mma.tu-darmstadt.de, [2]maric@mma.tu-darmstadt.de,
[3]aleksandar.vuckovic@stud.tu-darmstadt.de
[4] bothe@mma.tu-darmstadt.de

Keywords: *Multiphase Flow, Level Set Method, Redistancing*

The level set method introduced by Osher and Sethian [1, 2] is one of the most popular numerical methods to track a moving interface. It is based on the idea to represent the interface as the zero contour of a smooth function ϕ. Given a smooth velocity field $\vec{v} \in \mathbb{R}^n$ advecting the interface Σ, the usual *choice* for the transport equation for ϕ is the linear hyperbolic PDE

$$\partial_t \phi + \vec{v} \cdot \nabla \phi = 0. \tag{1}$$

Moreover, the initial value for ϕ is frequently chosen to be (locally) the signed distance to the interface since the latter has some convenient properties (e.g., to compute the mean curvature). However, one can easily show that a solution of (1) does not preserve the signed distance property. That is why reinitialization (or redistancing) algorithms are applied to restore the signed distance property after advection [2]. In this work, we propose a reformulation of (1) based on the fundamental kinematics of interfaces [3]. The resulting nonlinear PDE preserves $|\nabla \phi|$ at the moving interface. We show that, on the discrete level, it is sufficient to solve a linear equation for ϕ in each time step.

REFERENCES

[1] S. Osher and J. A. Sethian. Fronts propagating with curvature-dependent speed: Algorithms based on hamilton-jacobi formulations. *Journal of Computational Physics*, 79(1):12–49, nov 1988.

[2] F. Gibou, R. Fedkiw, and S. Osher. A review of level-set methods and some recent applications. *Journal of Computational Physics*, 353:82–109, jan 2018.

[3] M. Fricke, M. Köhne, and D. Bothe. A kinematic evolution equation for the dynamic contact angle and some consequences. *Physica D: Nonlinear Phenomena*, 394:26–43, 2019.

[4] M. Q. de Luna, D. Kuzmin, and C. E. Kees. A monolithic conservative level set method with built-in redistancing. *Journal of Computational Physics*, 379:262–278, feb 2019.