

# An analysis of parasitic current generation in Volume of Fluid simulations

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Since its development over one decade ago, the Continuum Surface Force (CSF) method has arguably become the pre-eminent tool used to model surface tension effects in Eulerian based Computational Fluid Dynamics (CFD) codes. The CSF model simulates the discrete stress change that occurs at a free surface due to capillary effects by a body force which acts throughout a small but finite fluid region surrounding the interface. The magnitude and direction of the force are chosen so that in the limit of this region becoming infinitely small, the correct capillary induced stress change at the interface is recovered.

Although the CSF model has been successfully employed to model a large variety of flow problems involving interfaces using various CFD methods (eg level-set, Volume of Fluid), its ability to model flows which are dominated by surface tension effects is limited by the existence of so-called ‘parasitic currents’. Parasitic currents are unphysical currents generated in fluid regions adjacent to an interface by local variations in the CSF body force. Their magnitude generally increases with increasing capillary strength, and may become so large as to affect the prediction of flow field velocities, or in more dire circumstances, cause complete breakup of an interface. While some modifications to the CSF method have recently been proposed to reduce the magnitude of these currents, at present there is no simple technique capable of eliminating them completely.

In this paper a correlation for the parasitic current magnitude as a function of physical and numerical parameters is determined. This is achieved by performing an order of magnitude analysis on the discretised Navier-Stokes equations with the CSF force included. The correlation is validated by comparing predicted velocity magnitudes against those obtained from a variety of numerical experiments, performed using a Volume of Fluid code. A secondary purpose of the paper is to determine how effective certain proposed modifications to the CSF model are in reducing parasitic currents, and to detail how these modifications may affect the overall flow solution.