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Explainable AI to Explore Physics Behind Fluid Mechanics

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Abstract

The advent of deep learning has emerged as a transformative technology for the classification of multifluid flow regimes. The advent of explainable AI has paved the way for enhanced interpretability of flow structures and dynamics. The transfer learning of the Locally Interpretable Model-agnostic Explanations (LIME) method, a prominent explainable AI technique, has been successfully implemented in both experimental snapshots and CFD scenes of droplet flow in a microchannel with a diamond-shaped device. The calculated scores of droplet images indicate that droplet coalescence is characterized by these droplet motions even from the inlet of the diamond-shaped device. In addition, a parametric survey explores the vital role of the hyperparameters of classification learning and image augmentation. The classification score maps for both experimental snapshots and CFD scenes showed high scores for droplets prior to coalescence. This indicates that droplet coalescence can be characterized by their motions even from the inlet of the diamond-shaped device. Image enhancement and hyperparameter optimization were found to improve the classification results. The study successfully applied the LIME method as an explicable AI to experimental snapshots and CFD scenes of droplet flow in a diamond-shaped device.

Keywords: Explainable AI, microchannel, droplet flow, droplet coalescence, experimental, CFD