A POWERFUL TENSIOMETER FEATURING DEEP LEARNING

A. G. Sourais, I. E. Markodimitrakis, A. G. Papathanasiou*

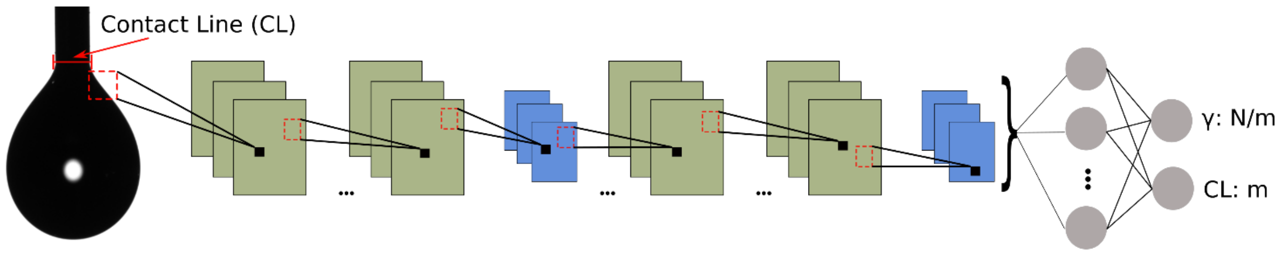
School of Chemical Engineering, NTUA, 15780, Athens

* *pathan@chemeng.ntua.gr*

ABSTRACT

Surface tension is a property of liquids that significantly affects wetting phenomena and the stability of liquid droplets [1]. The simplest (in terms of instrumentation), most robust, and most versatile among various methods for surface tension measurement is the pendant drop tensiometry[2]. In the usual ADSA (axisymmetric droplet shape analysis) pendant drop tensiometry, the surface tension is calculated after fitting the Young-Laplace (YL) force balance equation to the shape of a pendant drop which is extracted from an experimental image using image processing techniques; surface tension is the fitting parameter. Although relatively simple to implement and use, ADSA pendant drop tensiometry has some important disadvantages as high sensitivity to image resolution and quality, high sensitivity to ambient light or illumination and relatively high computational cost during the drop profile extraction and YL fitting, especially when portable measurement devices are considered, like single board computers or mobile phones [3]. Alternatively, Machine Learning (ML) algorithms can be used to identify the drop interface shape from the pendant drop images and estimate the value of the surface tension by classification [4] or regression.

In this work, we exploit the power of Convolutional Neural Networks (CNNs) and deep learning to directly estimate the surface tension from pendant drop images of any quality. For this purpose, we apply deep regression by training CNNs on an image dataset. The dataset contains thousands of images of different resolution, quality and light conditions obtained either from experiments or created numerically by solving the YL equation and applying data augmentation and artificial noise techniques.



KEYWORDS: Surface tension, Pendant drop tensiometry, Deep learning, Convolutional Neural Networks, Regression

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