

Report on Deep Learning Enhanced Background Oriented Schlieren for analysis of droplet Evaporation

Based on Work done by Partha Dutta , & KIRAN RAJ M

Name : Niraj Kumar Singh , Roll no : AM25M807

Introduction

The work is done to analyse the droplet evaporation after impact . This phe nomenon involves following multiphysics

1. Coupled Fluid Motion
2. Heat Transfer and Phase Change

the surrounding vapour cloud influences the evaporation rate and so on droplets lifetime and stability

Objectives

BOS Technique

in BOS technique , the fluid we want to study is placed between a random dot pattern and a camera ,then a picture is taken for refrence . then we take another picture when fluid is under study and compare both pictures .

Setup and Methodology

setup

1. background pattern : 20mm × 20mm field of view with dot size of 0.01mm(1pixel)

and 54% dot coverage

1. droplet generation and impact condition :
 1. dilute acetone-water solution (1:3) ratio
 2. diameter of droplet : 2.5mm
2. geometric Parameter of BOS
 1. Z_grad : distance between background and heated substrate
 2. Z_lens : distance between lens and background

Methodology

1. Two BOS video at 2000fps were recorded for reference and distorted background
2. frames were extracted , merged and cropped to 512 x 512 pixels
3. displacement field were obtained using cross correlation and physics based CNN to improve the quality of BOS images

Mathematical Modeling

Based on displacemnt field , required refractive index is found out

$$\frac{\partial n}{\partial x} = c\Delta x$$

$$\frac{\partial n}{\partial y} = c\Delta y$$

where $c = \frac{n_0}{2z_{\text{grad}}\Delta x_p}$, where n_0 is the refractive index of air, Δz_p is the half width of field of view obtained from image calibration.

Based on the boundary condition of refractive index of air around its refractive condition of mixture is calculated to find out the concentration of droplet after impact

Result Discussion and Conclusion

Comparison of resultant displacement field

Cross correlation captures the overall droplet evaporation structure, but spatial window averaging reduces the effective resolution and increases the noise robustness

Result and Conclusion

1. transverse droplet oscillations are observed after impact as evident in

resultant displacement field

1. these oscillations arise due to competition between initial impact inertial,

surface tension recoil and heat induced non uniform evaporation near the contact line on heated substrate