Application of Machine Learning aided convolution based algorithm for nuclear track detector (NTD) image analysis

Joydeep Chatterjee and Kanik Palodhi
Dept. of Applied Optics and Photonics, University of Calcutta

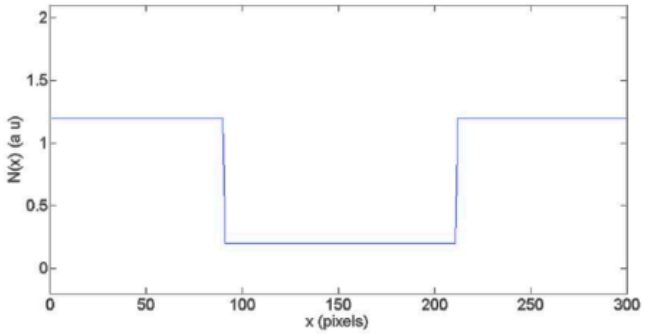
Presentation at MoEDAL group meeting on NTD and ML
03/04/20

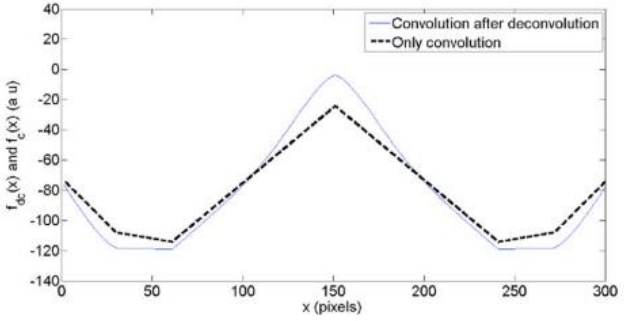
Introduction

- Image processing is an integral part of the NTD microscope image analysis.
- Many of the common image processing techniques require manual intervention to some extent.
- Relatively simple yet effective image processing technique based on deconvolution followed by convolution for NTD images was presented in the meeting held on 6th March 2020.
- Further automation has been done with the help of Machine Learning.

Recap of the proposed algorithm

- Mask selection $M(x, y)$ using a suitable NTD track from objects $N(x, y)$(NTDs present within image)
- First, a gaussian mask $G(x, y)$ chosen for deconvolution with $N(x, y)$
- Next, $M(x, y)$ convolved with entire image resulting in following images:
- For 1D:

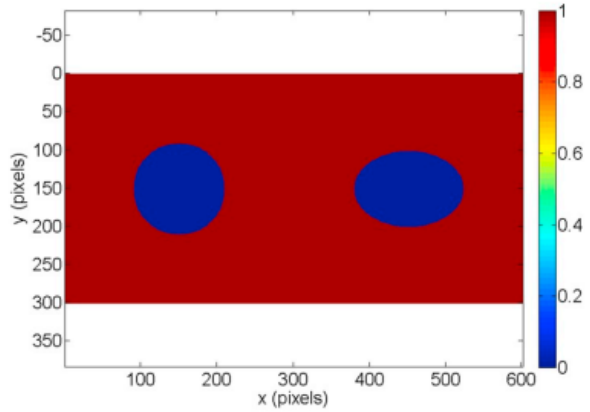


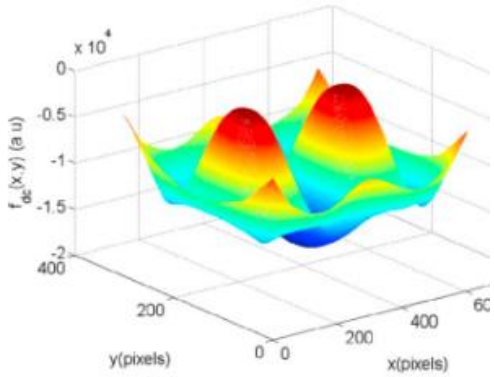


3 Kanik Palodhi *et al*, Convolution based hybrid image processing technique for microscopic images of etch-pits in Nuclear Track Detectors, Radiation Measurements, Volume 130, 106219, January 2020.

Recap of the proposed algorithm (Contd.)

- For 2D:





- Marking and counting done with manual thresolding
- This threshold level generally changes from one image to another

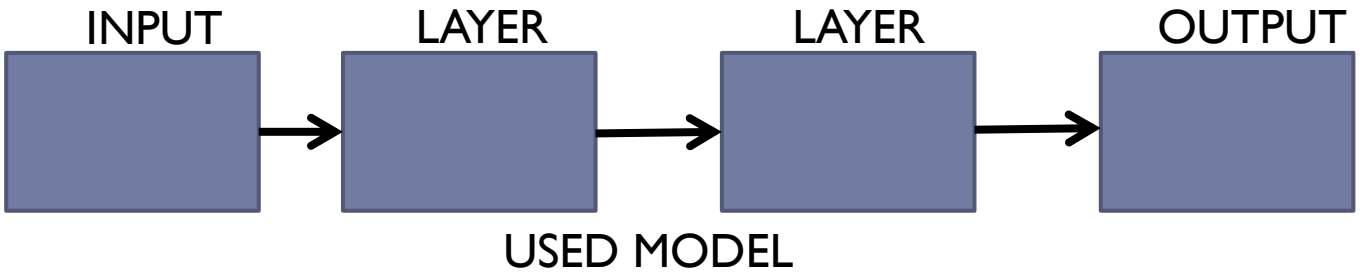
4 Kanik Palodhi *et al*, Convolution based hybrid image processing technique for microscopic images of etch-pits in Nuclear Track Detectors, Radiation Measurements, Volume 130, 106219, January 2020.

Incorporation of Machine Learning

- Introduction of Machine Learning to reduce manual intervention
- Neural network used
- Training done with 75% images of total dataset
- Different training sets for application to different types of images (0^{o}, 30^{o} accelerator images and field images)
- Reasonable accuracy achieved
- Computation done on ordinary computers

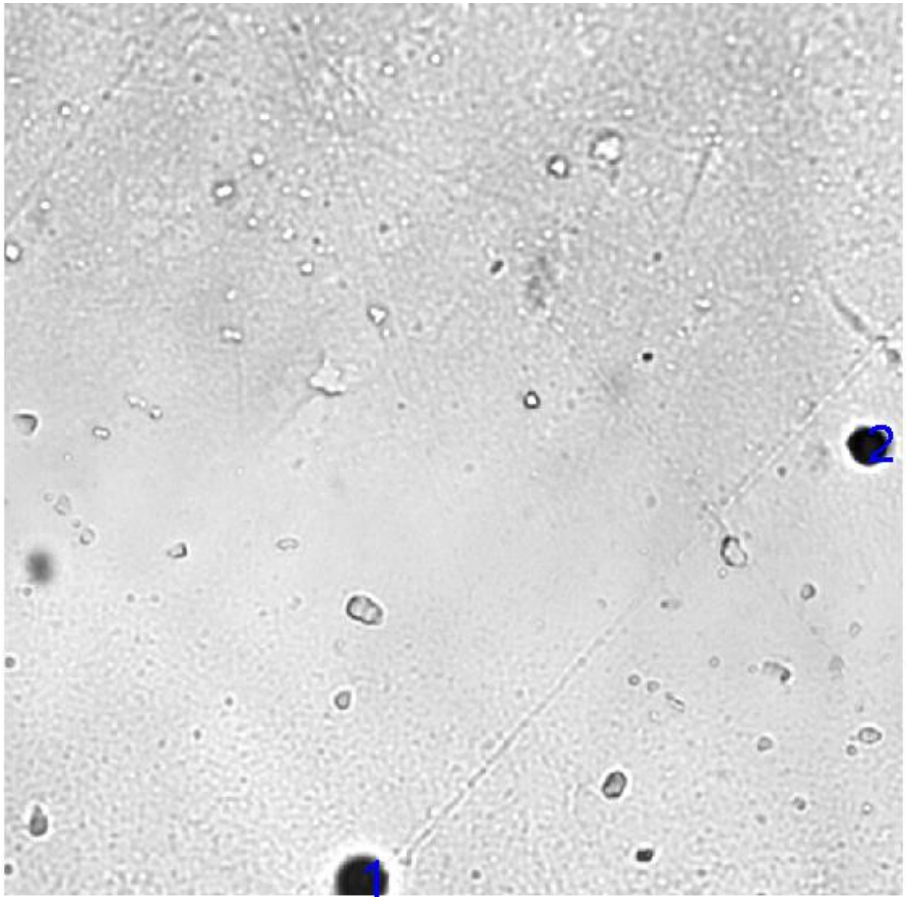
Details of the Machine Learning model

- Feed-forward network
- Data flows in a certain direction
- Average intensity and threshold for training
- Predicted threshold based on the average intensity for the sample
- Predicted threshold used and marking using morphological technique

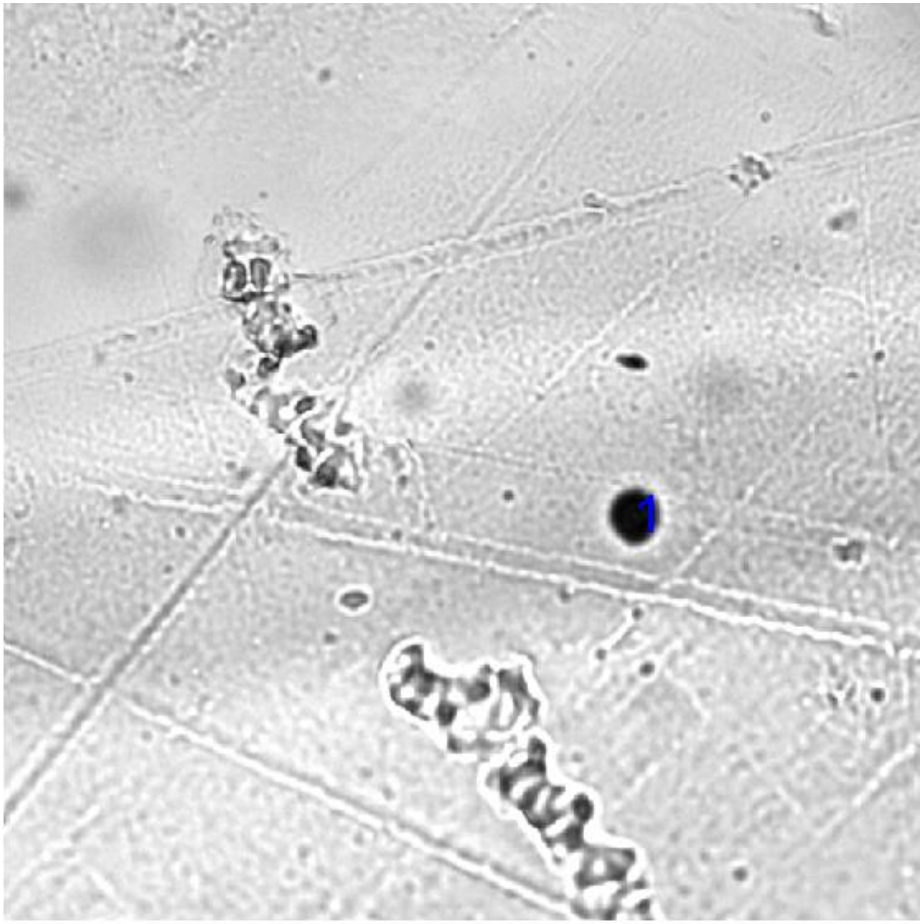


USED MODEL

Results for 0 degree incidence in accelerator



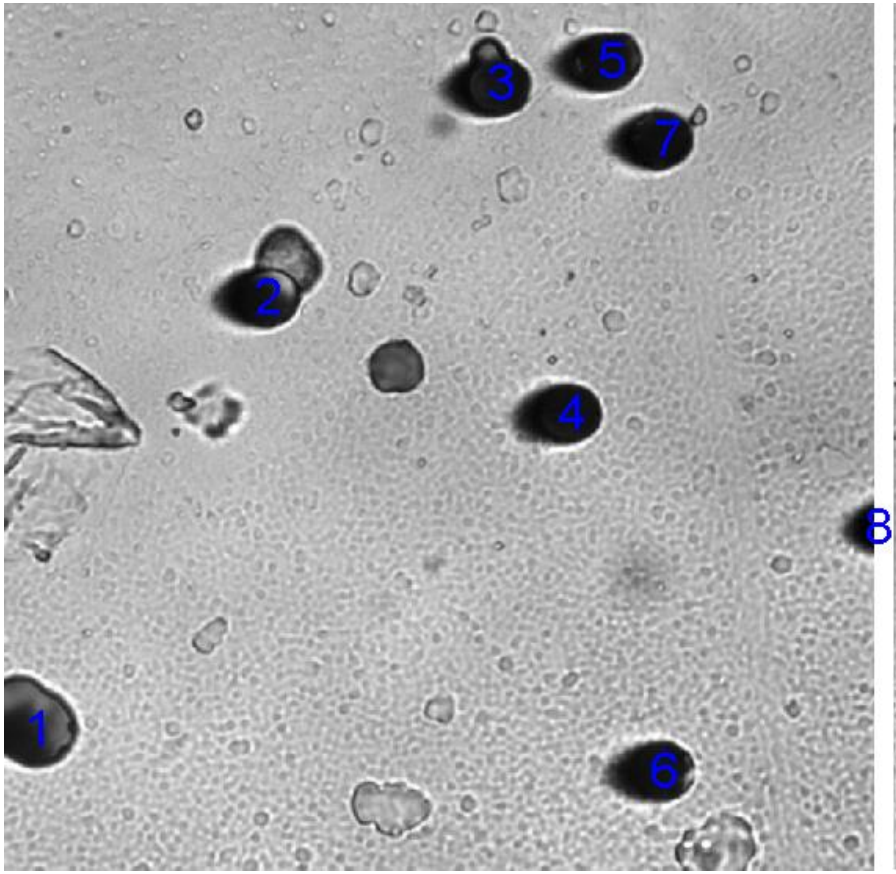
Total count 2



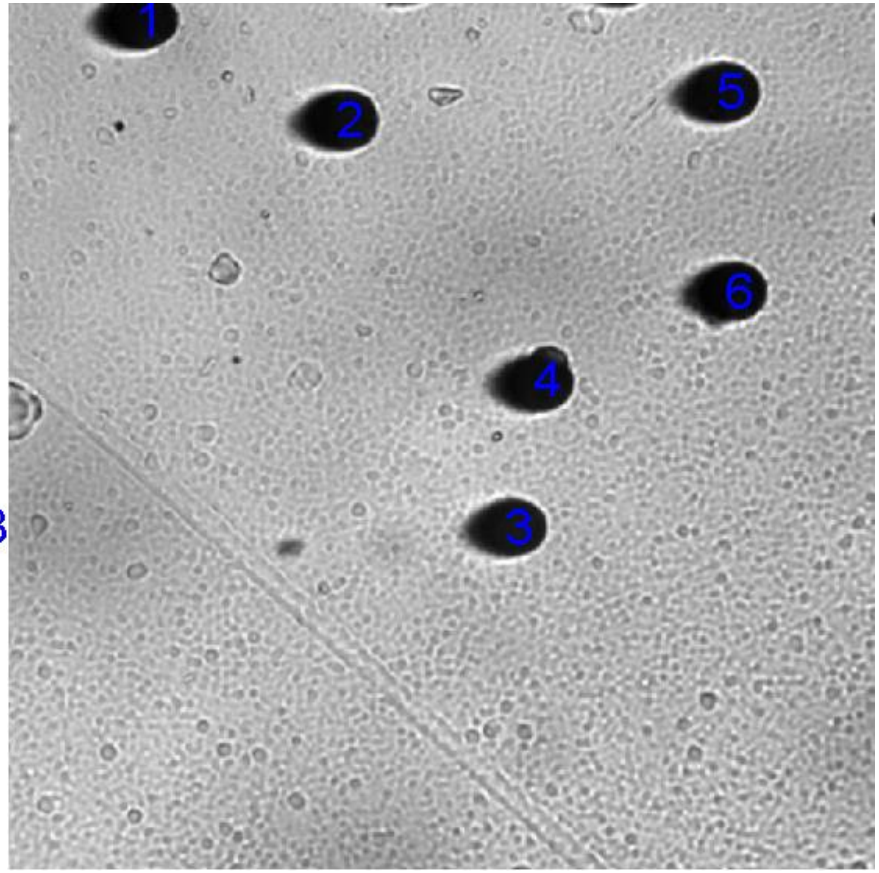
Total count 1

 Original images taken from Bose Institute, Kolkata, India

Results for 30 degree incidence in accelerator



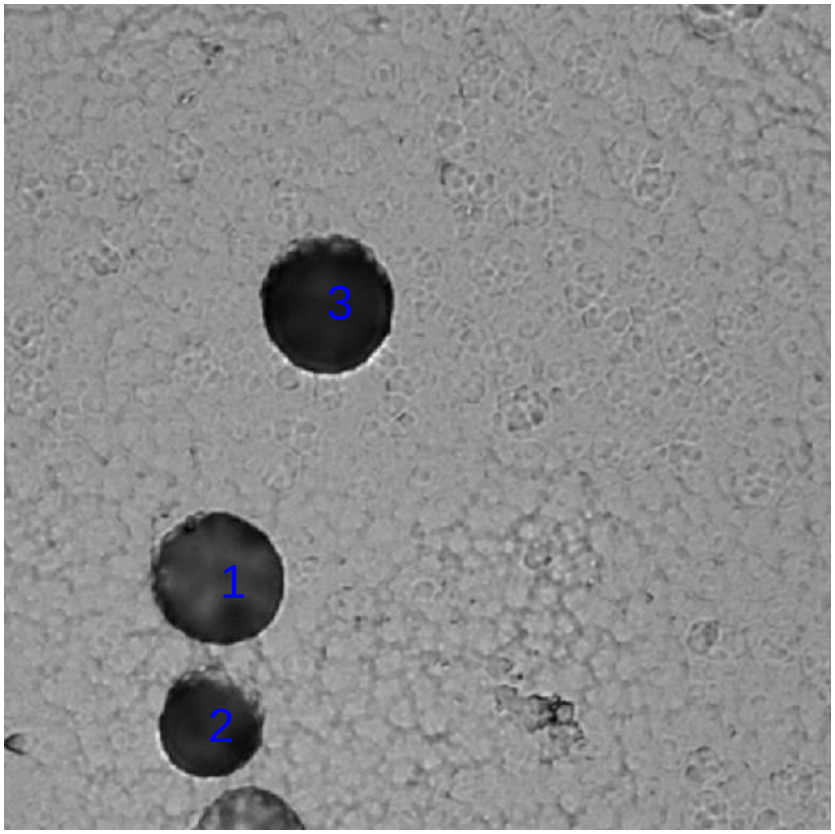
Total count 8



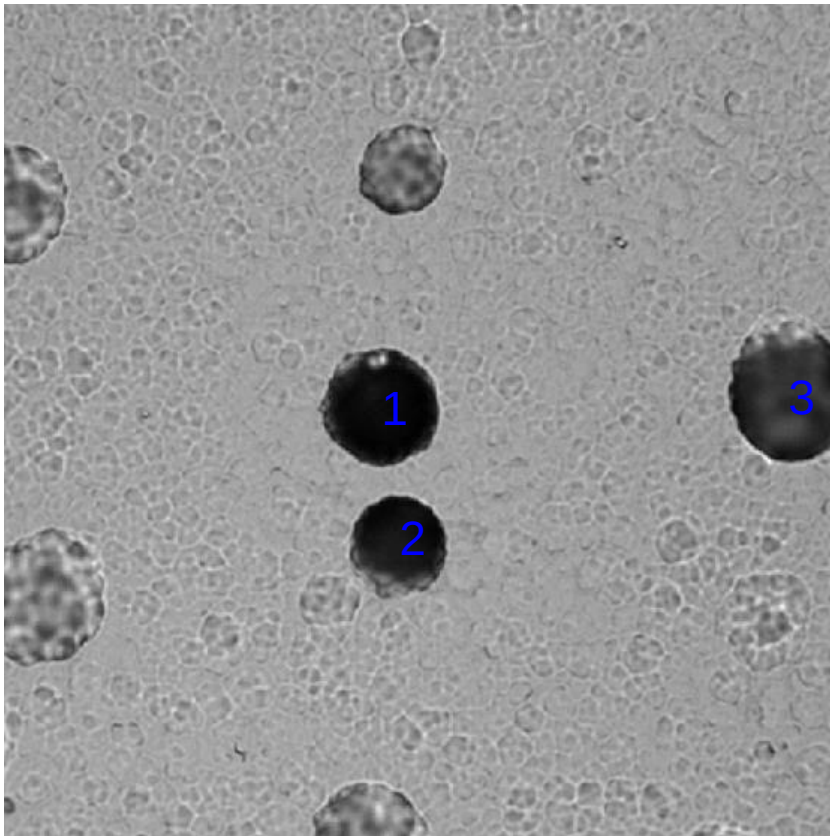
Total count 6

8 Original images taken from Bose Institute, Kolkata, India

Results for Darjeeling (field) images



Total count 3



Total count 3

 Original images taken from Bose Institute, Kolkata, India

Discussion

- Computation is fast and less resource hungry.
- No separate position determination algorithm is required.
- The marking is also automated.
- Partial visibility is also detectable to a large extent.
- Effects of noise and artefact has been dealt with quite successfully.
- The method is to be tested on much larger and diverse dataset.

THANK YOU