Machine Learning for Cell Identification

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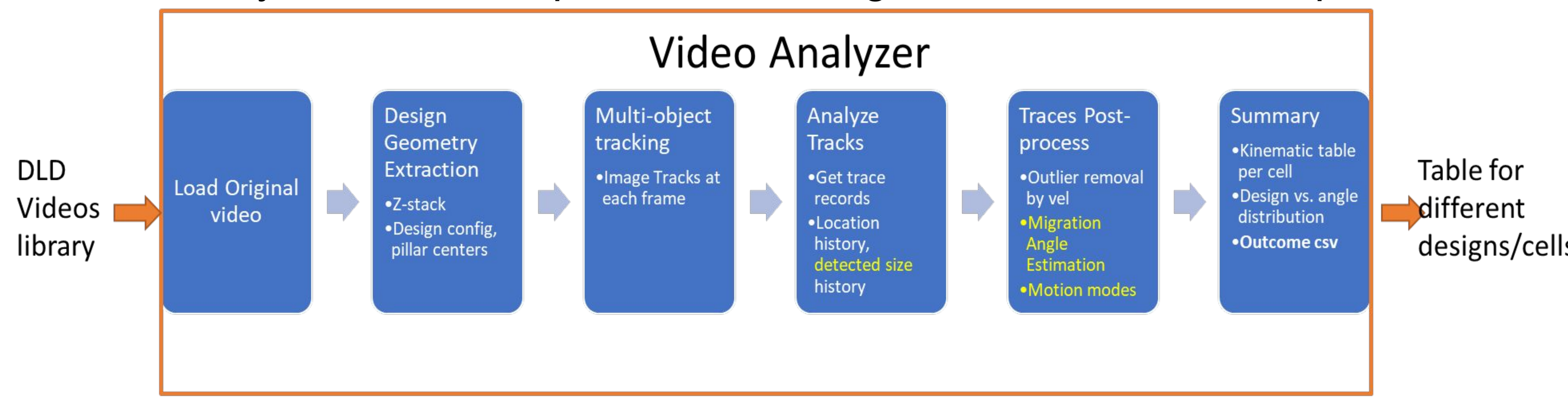
Abstract

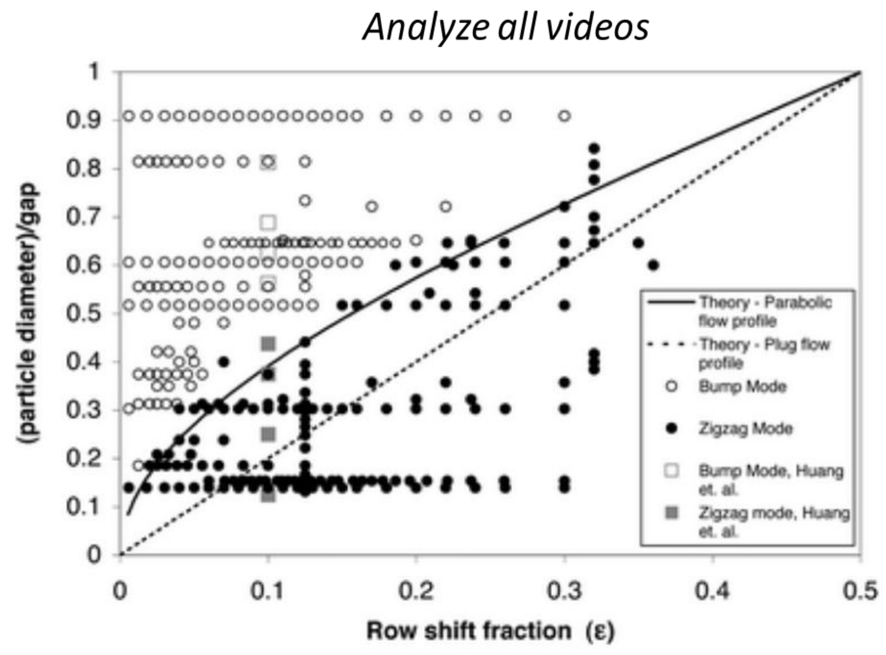
The focus of this project is on the development of images containing particles and improving object detection algorithm for biomedical/clinical application to identify various cells based on their unique characteristics. We have created an inspection algorithm to verify the integrity of the object detection algorithm of the particles captured including a user-friendly interface.

Background

The goal is to accurately identify and classify cells based on their cytometry. The cell sorter extracts features from images captured and are sorted based on their features.
Deterministic Lateral Displacement (DLD) separates continuous-flow microfluidic particles, it's used for passive particle sorting, and primarily based on particle size and tends to move in either zigzag or bumping due to their different sizes.
DLD designs are still under work, but to find the best sorting outcome takes time through trial and error.
We have done DLD experiments and the purpose of using machine learning is to learn the kinematics of the particles to predict their motions in DLD arrays in order to optimize the design with less tedious experiments.



Analyze all videos



The DLD videos captures various particles moving along pillars and this is where machine learning comes in. As shown above, the image demonstrates the process of how our data is extracted and collected through the object detection algorithm including the zigzag and bumping [1] of the particles.

Method

In MATLAB, the object-detection algorithm provided the following information: unique id, location history, diameter size, frame location in video, x and y axis, zigzag & bumping
User interactive selector includes:

- Video
- Cell
- Plot Features

Various particles are detected but a threshold was implemented to filter out false particles detected from the algorithm.
The post-processing algorithm provides information about:

- Coordinates of the unit cell pillars
  - Used to track the movement of the particle

The GUI is built through:

- Using data collected from object detection algorithm
- Creating a list of videos and how many cells are identified in each video, which can be selected by the user

Results

The first step in using the inspection algorithm is to run the object detection algorithm (Fig. 1) to extract information.

The results from the object detection algorithm provided data that helped with the implementations of various plot features for the inspection algorithm such as the location history and frame of a particle in the video.

Inspection algorithm helps save time in reanalyzing the entire video for inconsistent or confusing data values of different particles.

Plot features include:

- Trajectory plot (Fig. 2)
- Size band (Fig. 3)
- Highlighted Pillars (Fig. 4)

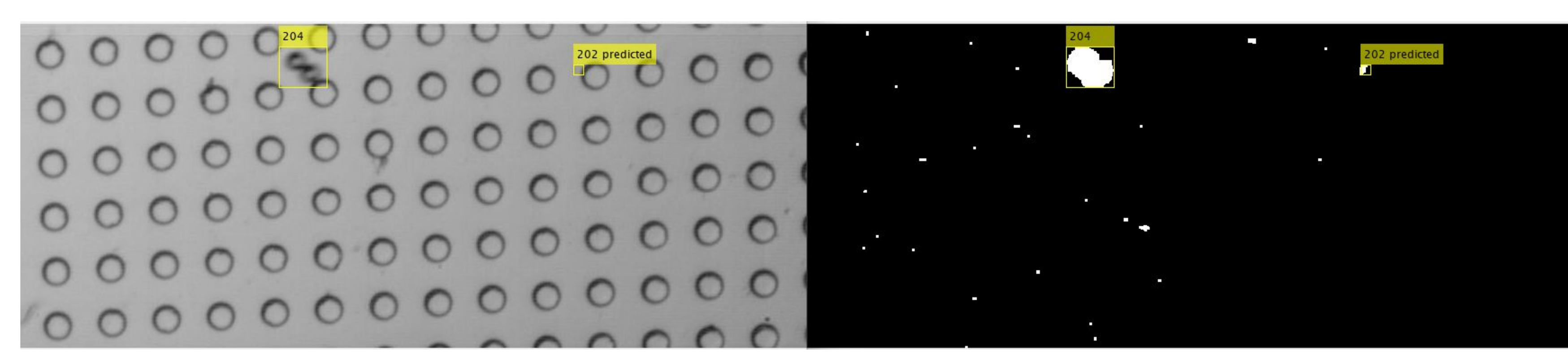


Figure 1: A visualization of the object detection algorithm identifying particles with a side-by-side demonstration of the video and the bit masking.

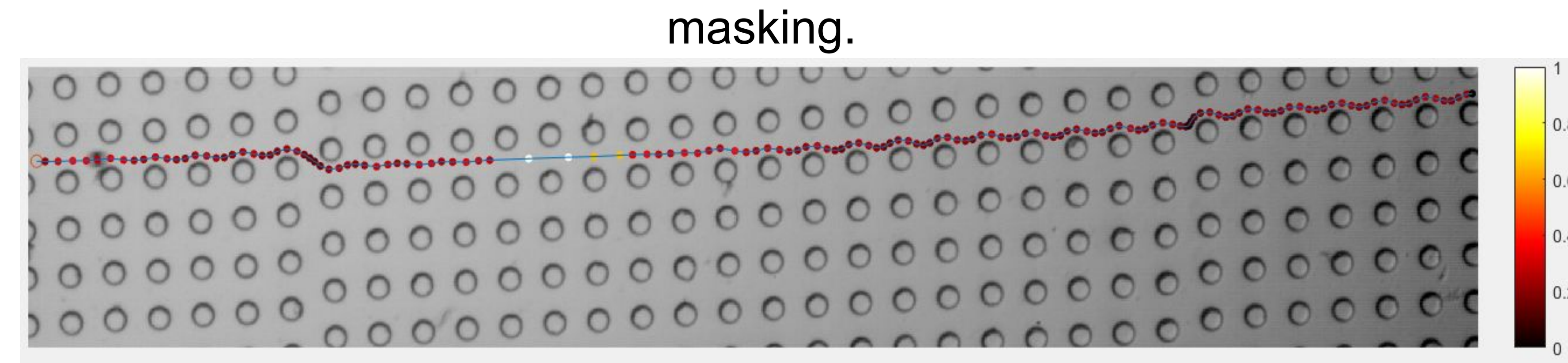


Figure 2: An arbitrary particle's trajectory plot is shown with varying color intensity based on the particle's velocity

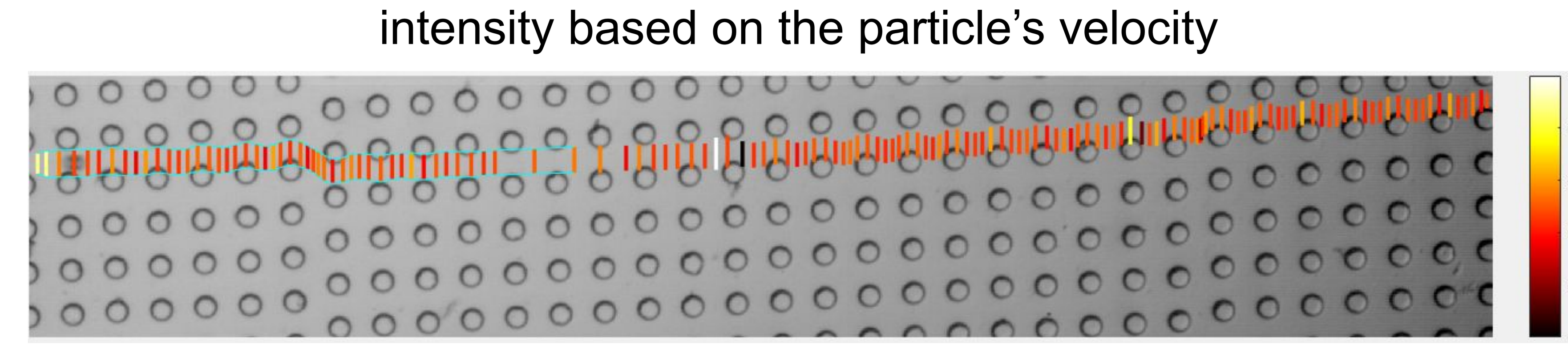


Figure 3: Size band of the particle's movement is captured with respect to the diameter.

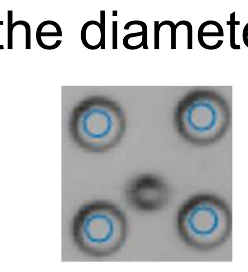
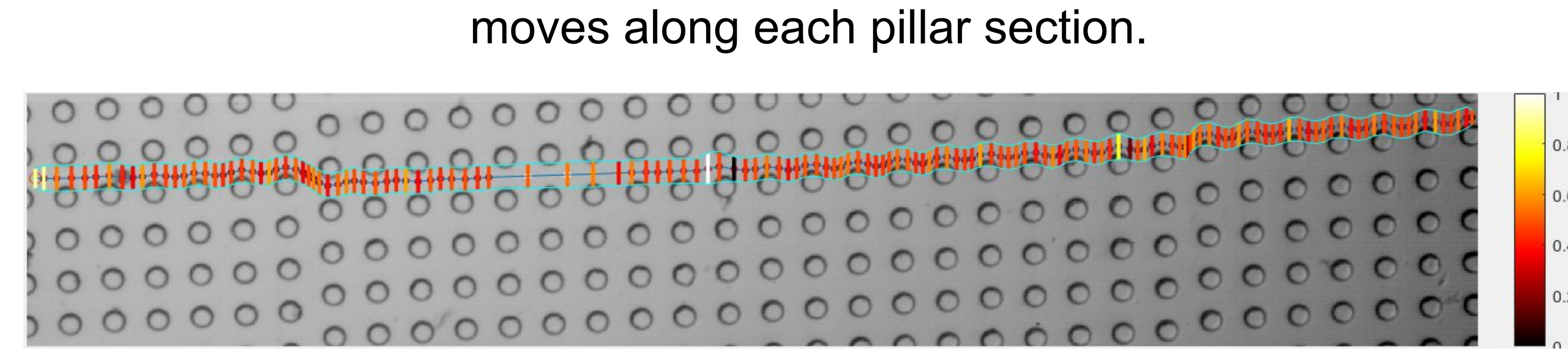


Figure 4: The highlighted pillar tracks the movement of the particle as it moves along each pillar section.



The plot demonstrates the trajectory, size diameter, and highlighted pillar can be plotted together.

Acknowledgement(s):

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[1] McGrath, J., et al. "Deterministic Lateral Displacement for Particle Separation: A Review." *Lab on a Chip*, The Royal Society of Chemistry, 4 Sept. 2014, https://pubs.rsc.org/en/content/articlelanding/2014/lc/c4lc00939h#!

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