Machine Learning Cell Type Classification for Cancer Diagnosis

Poplar Yang, Daniel Karkhut, Zach Laswick, Daolong Liu, Muyuan He, Ratul Paul, Shen Wang, Yaling Liu.
Department of Bioengineering, Lehigh University, Bethlehem, PA

Introduction

- Cell imaging and biophysical analysis are crucial tools in the study of cancer detection and clinical treatment.
- Cell deformability and mechanical properties are important biomarkers for cancer cells detection.
- This study aims to use the deformability index (DI)- the ratio of the major axis to the minor axis- in a narrow constriction microfluidic channel to differentiate white blood cells (WBCs) from cancer cells (HCT-116). An automated imaging processing code analyzes the cell motion and plots the velocity change and DI of each cell which will be used to identify the cell type.

Cell Culture & Cell Collection

- HCT-116 cells were formed using standard cell culturing method and diluted with Phosphate Buffered Saline in a 1:5 ratio prior to the experiment.
- WBCs were extracted from bovine whole blood sample. Red blood cell lysis was used to isolate the WBCs in the sample.

Microfluidic Device Setup

- A polydimethylsiloxane (PDMS) microfluidic device was constructed with a height of 40μm, containing 10 narrow constriction channels each having a width of 7.5μm.
- Two glass slides containing inlet/outlet holes on the top and bottom of the device were clamped using multiple 3D-printed frames to make the device reusable, shown in Figure 1A.
- The imaging was done at 5000 fps with a 10μs exposure time, example image shown in Figure 1B.

Image Processing Code

After testing the two types of cells in the microfluidic device, the machine learning Python code generated three cropped images for each cell being analyzed: before the entry of channel, during/ in the middle of the channel, and upon the exit of the channel, shown in Figure 2.

Results

- An automated imaging processing Python code marked the DI of each cell being analyzed before the entry of the channels, within the channels, and after exiting the channels. The DI value of each cell was compared and used to classify the cell type.
- The accuracy of differentiating HCT-116 and WBC is about 95%. An example output is shown in Figure 3.

Conclusion & Future Works

- It was proven that there is a noticeable difference between the DI of HCT-116 cancer cells and that of WBCs. As a result, this techniques could be used in making a cancer diagnostic device in detecting cancer cells for patients to potentially start treatment at an earlier phase.
- Future works can be done to improve the microfluidic device, in replacing the PDMS with glass, creating more stable and rigid channels that would constantly produce accurate data for DI analysis.

Acknowledgement

- David and Lorraine Freed Undergraduate Research Symposium, Lehigh University