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主　論　文　の　要　旨

論文題目　**Detection of T-cells and B-cells for Blood Analysis System Using Microfluidic Chip**

(マイクロ流体チップを用いた血液細胞分離システムによるT細胞・B細胞の検出)

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論　文　内　容　の　要　旨

This thesis presents a blood analysis system for the isolation and detection of T-cells and B-cells. Providing an accurate count of total leukocytes from limited amounts of blood is a rather challenging ordeal.

First, we introduce the microfluidic chip that is designed and fabricated for the isolation of T-cells and B-cells. A micro-pillar array based gradual filtering with anti-clogging strategies such as escape routes is used to isolate the T-cells and B-cells from sub-microliter of whole blood. Based on the difference in size and deformability, leukocytes were separated from other blood cells by micropillar arrays. We confirmed the microfluidic chip is clog-free. Using the microfluidic chip, a trap rate of 99.8% is

achieved.

Then we introduced a machine learning algorithm to detect T-cells and B-cells. The variability of cells in size, morphology and color intensity along with the emission spectrum crosstalk between fluorescence dyes make cell detection among pillars extremely difficult. A Support Vector Machine (SVM) supervised machine learning classifier based on both Histogram of Oriented Gradients (HOG) and color distribution features was proposed to distinguish T-cells and B-cells in a rapid and robust manner. HOG features were utilized to detect cells from background and noise; color distribution features were employed to alleviate the effect of fluorescence spectrum crosstalk. The experiment showed we achieved an average detection accuracy of 94% for detecting T-cells and B-cells from the background. Furthermore, we also got 96% accuracy with cross validation to detect T-cells from B-cells.

Finally, we propose a Convolutional Neural Network (CNN) to further increase the accuracy of the detection. A CNN is trained and used to distinguish T-cells and B-cells with an accuracy rate of 98%, a specificity of 99% and a sensitivity of 97%. We also propose an HOG feature based SVM classifier to preselect the detection windows to accelerate the detection to process images in less than 10 mins. The proposed on-chip cell detecting and counting method will be useful for numerous applications in diagnosis and for monitoring diseases.