Name(s)	Project Number
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Project Title

A Handheld Hematology Analyzer Using Acoustic Enhanced Blood Smear Devices

Abstract

Objectives/Goals
The goal of this project is to develop an inexpensive handheld hematology analyzer that can concentrate and separate white blood cells (WBCs) from red blood cells (RBC), and capture cell images using a smartphone based microscope, followed by automatic cell morphology recognition and cell counting using cell image analysis software.

Methods/Materials
The microfluidic device, designed based on microvortex technology, was fabricated using soft lithography and consisted of pockets that were used to store air bubbles to generate microvortex force, which concentrated and separated WBCs from RBCs around the air bubbles in the microchannel. The iPhone based microscope was built using Legos, a set of lenses, and an LED light source. The image analysis program was developed using two image editing software: ImageJ and CellProfiler. Human blood samples were tested using this handheld analyzer.

Results
Experiments revealed that the acoustic enhanced microchannel devices successfully concentrated and separated WBCs from RBCs using microvortex technology. The rectangular lateral cavities is more effective for cell concentration and separation than the circular cavities. The device achieved highly efficient blood cell separation (89% rate) similar to that of conventional centrifugation. Two inexpensive iPhone based microscopes were built with different magnification: 30x and 100x. These handheld microscopes possessed a comparable image quality of a conventional microscope. For automatic cell image analysis, both CellProfiler and ImageJ were evaluated. CellProfiler proved to be more accurate in cell counts than ImageJ.

Conclusions/Discussion
An integrated handheld hematology analyzer has been successfully demonstrated. This analyzer consists of: 1) an acoustic enhance blood smear microfluidic device that was used to concentrate and separate WBCs from RBCs; 2) an iPhone based handheld microscope (both 30x and 100x). In addition, automatic cell image processing methods were developed for cell counting. This handheld analyzer is simple and low-cost and has a potential to change how blood tests are performed and save tens of thousands of lives in developing countries.

Summary Statement

I have successfully turned a smartphone into an inexpensive handheld hematology analyzer, which consists of an acoustic enhanced blood smear, an iPhone-based microscope, and software to perform automatic blood cell counting and recognition.

Help Received

Used lab Equipment at UC-Irvine under the supervision of Prof. Abe Lee.