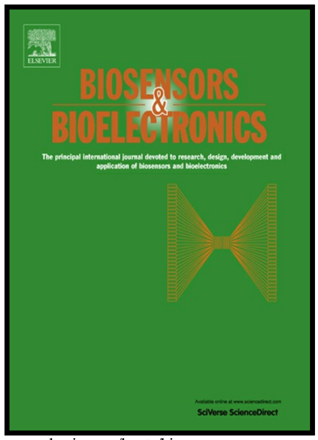
Author's Accepted Manuscript



www.elsevier.com/locate/bios

Scaling Code-Multiplexed Electrode Networks for Distributed Coulter Detection in Microfluidics

Ruxiu Liu, Ningquan Wang, Norh Asmere, A. Fatih Sarioglu

PII: S0956-5663(18)30585-2
DOI: https://doi.org/10.1016/j.bios.2018.07.075
Reference: BIOS10664

To appear in: *Biosensors and Bioelectronic*

Received date: 10 May 2018
Revised date: 18 July 2018
Accepted date: 30 July 2018

Cite this article as: Ruxiu Liu, Ningquan Wang, Norh Asmere and A. Fatih Sarioglu, Scaling Code-Multiplexed Electrode Networks for Distributed Coulter Detection in Microfluidics, *Biosensors and Bioelectronic,* https://doi.org/10.1016/j.bios.2018.07.075

Scaling Code-Multiplexed Electrode Networks for Distributed Coulter Detection in Microfluidics

Ruxiu Liu[a], Ningquan Wang[a], Norh Asmere[a], A. Fatih Sarioglu[a,b,c,*]

[a]School of Electrical and Computer Engineering, Georgia Institute of Technology, Atlanta, GA 30332, United States
[b]Petit Institute for Bioengineering and Biosciences, Georgia Institute of Technology, Atlanta, GA 30332, United States
[c]Institute of Electronics and Nanotechnology, Georgia Institute of Technology, Atlanta, GA 30332, United States

Abstract

Microfluidic devices can discriminate particles based on their properties and map them into different locations on the device. For distributed detection of these particles, we have recently introduced a multiplexed sensing technique called Microfluidic CODES, which combines code division multiple access with Coulter sensing. Our technique relies on micromachined sensor geometries to produce distinct waveforms that can uniquely be linked to specific locations on the microfluidic device. In this work, we investigated the scaling of the code-multiplexed Coulter sensor network through theoretical and experimental analysis. As a model system, we designed and fabricated a microfluidic device integrated with a network of 10 code-multiplexed sensors, each of which was characterized and verified to produce 31-bit orthogonal digital codes. To predict the performance of the sensor network, we developed a mathematical model based on communications and coding theory, and calculated the error rate for our sensor network as a function of the network size and sample properties. We theoretically and experimentally demonstrated the effect of electrical impedance on the signal-to-noise ratio and developed an optimized device. We also introduced a computational approach that can process the sensor network data with minimal input from the user and the demonstrated system-level operation by processing suspensions of cultured human cancer cells. Taken together, our results demonstrated the feasibility of deploying large-scale code-multiplexed electrode networks for distributed Coulter detection to realize integrated lab-on-a-chip devices.

Keywords: Coulter sensing; microfluidics; coding; multiplexing