# D15-026

## An Intelligent Digital Micro-fluidic Processor for Biomedical Detection

## 一款應用於生醫藥檢之智能微流道處理器

**隊名** 小蘋果
**隊長** 賴義澤 / 交通大學電子工程研究所
**隊員** 許銘峰 / 交通大學生醫工程研究所
喻柏憲 / 交通大學電子工程研究所

**指導教授** 李鎮宜 / 交通大學電子工程學系

## 作品摘要

當基於介電層電潤濕的數位微流體生醫晶片有更多的應用及潛力，由於生醫檢測的需求趨勢：多種檢體同時感測、更複雜的檢體操控、反應資訊讀回、系統自動化進行資源管理，我們期待生醫晶片的功能性和複雜度都能顯著提升。

一款智能的數位微流體處理器將發表呈現。這個實驗室晶片是從電路設計到架構規劃至系統自動化以及應用層面所發展完成，所述實驗室晶片實現了液珠控制、致動、液珠位置感測和電容式測量窗口的功能。再者，其可自我測試電路的正確性、不正常的操作電極、後製程後的晶片表面平整性與多種液珠的位置感測。這種新穎的實驗室晶片雛型解決許多傳統上的發展瓶頸並實現簡易操縱、易於監視、系統自動化和適用於生醫檢測所需的高精準度感測需求。該晶片使用標準的 0.35 微米 CMOS 製程製作，本文呈現 30x60 微電極之實驗室晶片雛型，並採用高解析度、低功耗之讀出電路來當成電容式反應觀測窗。測量結果顯示，微液珠可以如使用者規劃所操作，而且液珠位置感測具 1.3fF 電容分辨率和可感測到 0.39fF 電容變化之高解析度讀出電路。這些實驗結果充分突顯出，本文所提出之智能型數位微流體處理器可以以非常有效的方式被用於大量的生物檢測。

As the electro-wetting-on-dielectric (EWOD)-based digital micro-fluidic biochips find more applications and show their potentialities, the functionality and complexity are expected to increase and co-improve significantly due to the trend of multiple and concurrent assays on the chip, as well as more sophisticated control, reaction information read-back and system automation for resource management.

An intelligent digital micro-fluidic processor is presented. From circuit, architecture, system, to application, the work integrates the functions of droplet control, actuation, location sensing and capacitive measurement window. Further BIST for circuitry, faulty microelectrodes, chip flatness after post-fabrication, and droplet category classification are achieved. This novel prototype solves lots of traditional development bottlenecks to implement the easy-to-control, easy-to-monitor, system automation and high accuracy sensing for bioassay detection purposes. Fabricated in standard 0.35μm CMOS process, this prototype occupies 30x60 microelectrodes with measurement window, where the high resolution capacitive readout circuit is employed. Measured results show droplet examines can be functioned and the sensitivity of location detection is 1.3fF and 0.39fF for high resolution readout circuit. These experimental results highlight that our proposal can be used for the huge amount of bioassays and big-data analysis in a very efficient and effective way.

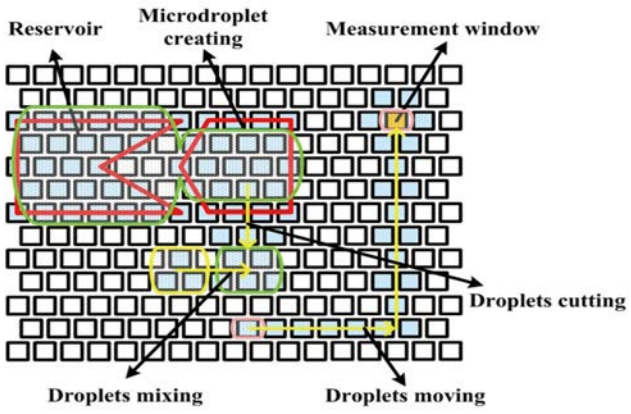


圖 1 / FPLOC 操作示意圖

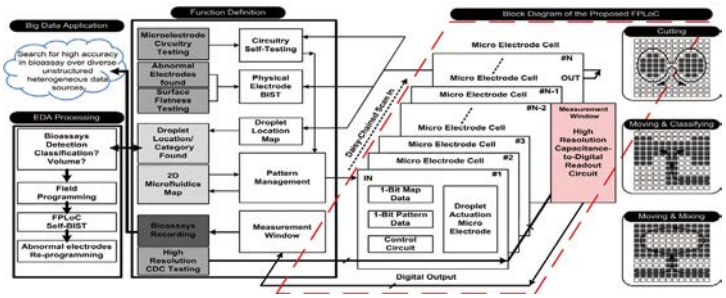

圖 2 / 系統架構方塊圖
The block diagram of our proposed bio-processor (FPLOC)