



The Chinese University of Hong Kong
Department of Biomedical Engineering



Graduate Seminar – PhD Oral Defence

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Date : 9 April 2026 (Thursday)
Time : 9:00 am
Venue : Room 1122, William M W Mong Engineering Building, CUHK

Title: A Lab-on-a-Disc Microfluidic Platform for Droplet-based Bio-detection Applications

Droplet-based bio-detection, particularly digital droplet PCR (ddPCR), enables absolute nucleic acid quantification. However, commercial systems are bulky, complex, and costly, hindering decentralized use. This thesis addresses this challenge by developing a comprehensive Lab-on-a-Disc (LOAD) microfluidic platform for portable, low-cost bio-detection applications.

First, a fully integrated LOAD ddPCR platform was implemented. The system integrates (i) a centrifugal chip for pump-free droplet generation, (ii) a circulating oil-based heat exchanger for precise thermocycling, and (iii) an on-disc fluorescence imaging subsystem. This architecture achieves droplet generation, thermocycling, and readout within a single compact device, enabling a true sample-to-answer workflow without external instrumentation. Performance validation using influenza A virus (IAV) DNA across a 10^7 -fold dilution gradient demonstrated a detection limit of 20.24 copies/ μL . The platform successfully quantified five clinical viral samples. Proof-of-concept on-site detection using the integrated imaging system confirmed the device's capability for decentralized clinical testing. To ensure quantitative rigor, standard Poisson statistical modelling was enhanced with a polydisperse correction model. Incorporating individual droplet volumes and maximum likelihood estimation, this model provides a robust theoretical framework that improves quantification accuracy at low concentrations.

Additionally, a gravity-actuated vertical LOAD architecture was explored for spatial thermocycling. Force and thermal analyses demonstrated this novel droplet carrier relocation mechanism as an energy-efficient alternative for rapid centrifugal amplification.

Overall, this work advances droplet-based bio-detection and portable molecular diagnostics through system integration, quantitative modelling, and architectural innovation.

***** ALL ARE WELCOME *****

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