

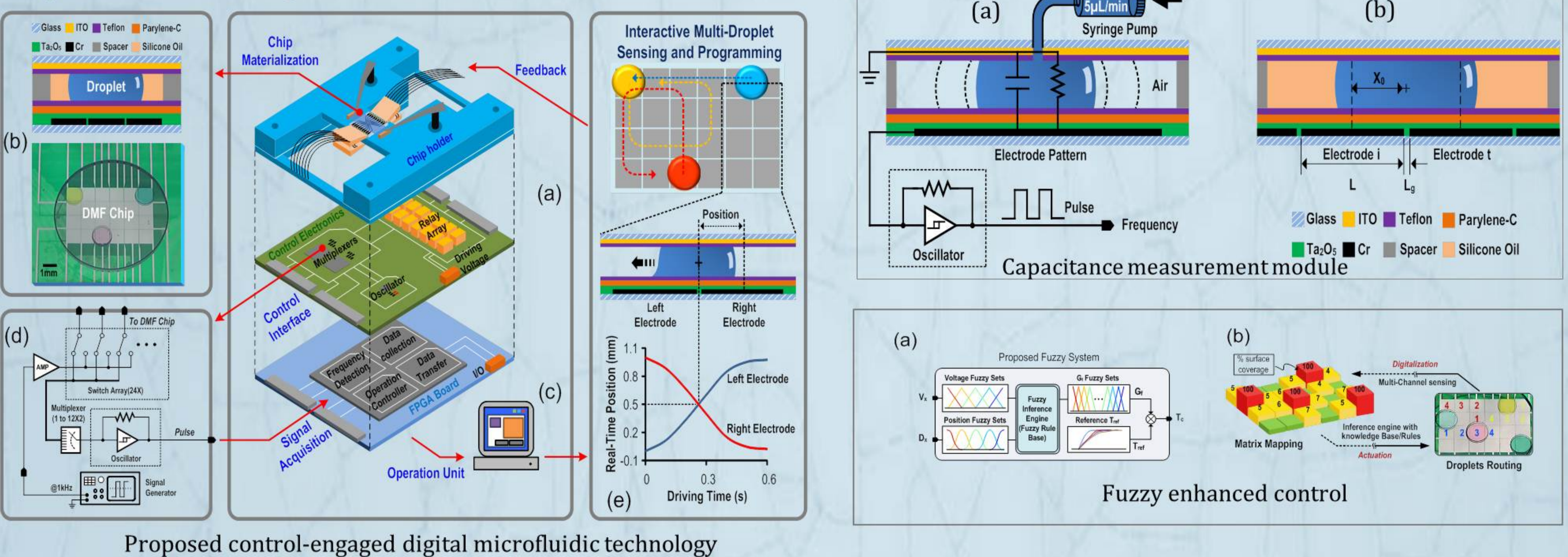
# An Intelligent Digital Microfluidics with Autonomous Positioning and Fuzzy-Enhanced Feedback Control

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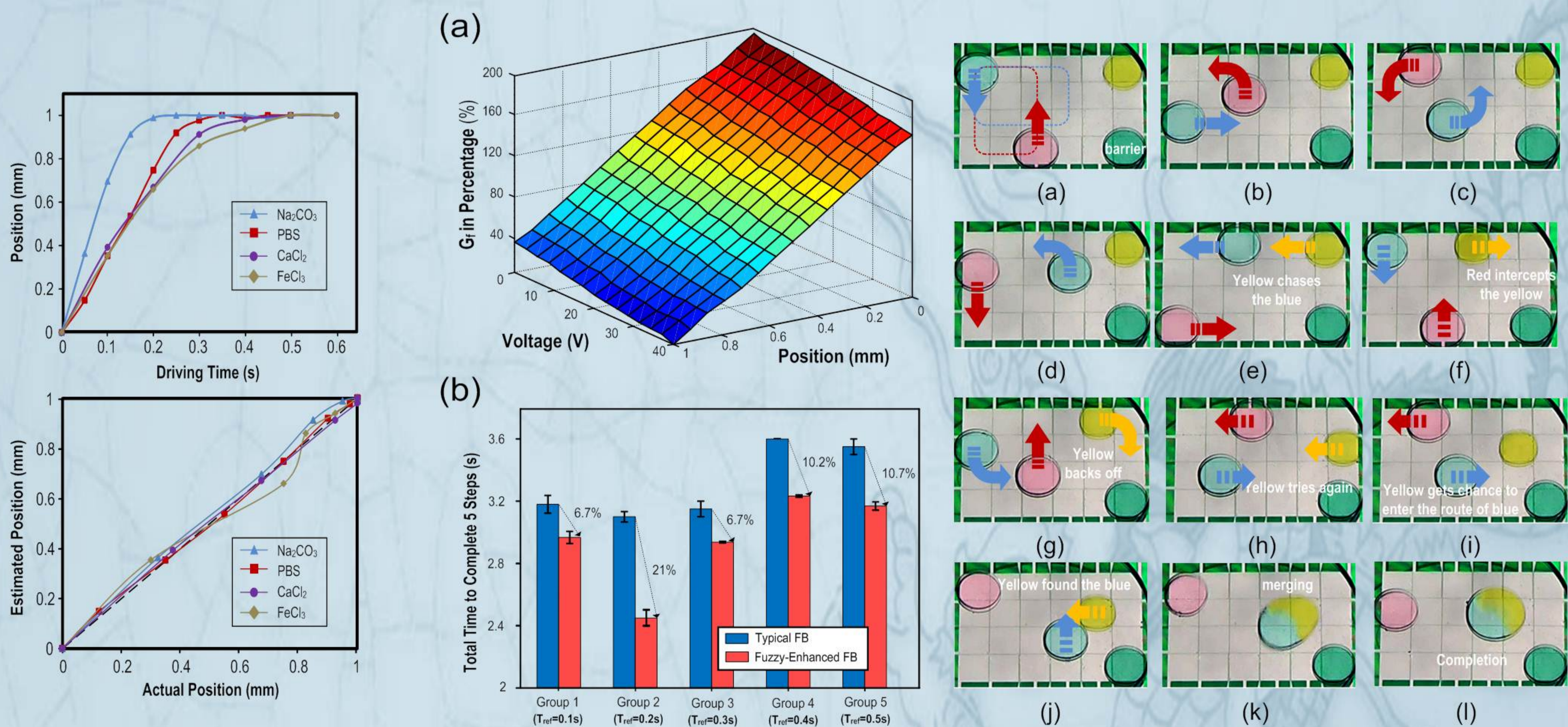
**Motivation:** The intricacy in the hydrodynamics of droplets with various chemical and biological compositions on a digital microfluidic (DMF) chip undermines its application in a large-scale microreactor system. Intelligent control can be conducted to play a key role in managing a sophisticated DMF system as well as assisting such a system in bridging between life science and microelectronics. In this work, we propose an intelligent digital microfluidics with fuzzy-enhanced controllability and expert manipulability to enhance the fidelity and reliability of each droplet operation, allowing future manufacturability of a wide range of life science analyses and combined chemical screening applications.

## Experimental design



Proposed control-engaged digital microfluidic technology

## Results



Real time position measurement

Fuzzy control for droplet movement

Expert control for multi-droplet movements

**Conclusions:** Taking the hydrodynamics and the control requirement of droplets into consideration, we built a conceptual intelligent DMF system from two aspects: (1) a fuzzy logic control-engaged charging time during the dynamic stage of a droplet; (2) and an expert controller, which managed the moving routes of droplets according to the status of the other droplets in the DMF system and the stored rules of experienced DMF biochemical operators in the coordinator. Compared with a bare feedback controller, our intelligent DMF controller acquired an up to a 21% shorter charging time and as a result, unnecessary lifetime degradation of DMF chips was minimized. Nevertheless, based on our real-time position-driven droplet maneuver module, our controller made countermeasure decisions for multiple droplet routing and an autonomous management of a DMF system was achieved.