Digital Microfluidic Technology

Digital Microfluidic Biochips (DMFBs) are an emerging “lab-on-a-chip (LoC)” technology that perform biochemical reactions by operating on fluidic droplets on the scale of nano-liters.

Applications:
- Clinical pathology
- Point of care diagnostics
- Drug discovery
- Proteomics, DNA, PCR, etc.
- Real-time detection of biochemical terror attacks

Key advantages:
- Reduced cost
- Reduced reagent and sample sizes
- Increased throughput and efficiency
- Increased sensitivity and accuracy
- Automation and miniaturization

Preventing Droplet Deadlock in Rotaries

An Exchange Rotary (ER) is the clockwise inner loop which allows droplets to move from one tile to its neighbor tiles.

ER deadlock occurs when four droplets attempt to pass through the ER simultaneously. ER deadlock is prevented by allowing, at most, three droplets that wish to pass through the ER to enter concurrently.

A Chamber Rotary (CR) is formed by the four streets (→, ↓, ←, ↑) and intersections (Ⅰ) surrounding the work chamber.

CR deadlock occurs when no droplet in the CR can move in the counter-clockwise CR loop without interfering with another droplet. To prevent CR deadlock, no droplet may enter an ER unless there is an open spot for it on the destination CR street.

Evaluation of DTP on Low-Powered Intel Atom™

Routed a common “PCR” benchmark with 5 routing sub-problems:
- Online computation time for entire benchmark is only 13.83ms (10.6s for Offline)
- Online routing spends 2.23ms, at most, computing routes during any routing cycle (if this number is less than 10ms (100Hz DMFB), routes can be computed in real-time, providing maximum flexibility and fault-tolerance potential)
- Offline routing time is 15 cycles (0.15s if 100Hz DMFB) shorter than online

Performed routing stress test on DMFBs of varying size. 5 droplets were input at each input port, traveled to 2 random chambers each, and then output at a random output port.

- 2x2 & 3x3 can run in real-time on a 100Hz DMFB driven by the Atom™
- 4x4 & 8x8 are too complex for the Atom™ to compute in real-time, but can quickly route up to 160 droplets simultaneously in less than 4s

Contact

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