

High-Speed Single Cell Dispensing System



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How to realize high-speed and high-accuracy single cell dispensing?

Abstract:

In this paper, we discuss the single cell dispensing system to increase both the speed and the success rate of single cell dispensing. Two pairs of capacitance sensors are placed in a biochip to detect the flow velocity of cells, and the air pressure is applied to eject cells by synchronizing the timing. Then, the system theoretically has a capability to eject 3 cells/sec with maximum flow velocity is 10 mm/sec. Finally, we succeeded in automatic dispensing of single polystyrene bead ($\approx 100 \mu\text{m}$) using developed cell ejection system with the success rate of 45 %. Furthermore, we also succeeded in single swine oocyte dispensing by developed system.

Background:

Motivation **Microbeads for evaluation of single cell**

Adhered cell ($> \phi 10 \mu\text{m}$) Particle ($< \phi 100 \mu\text{m}$)

$\phi 100 \mu\text{m}$

Particle dispensing

Okochi et al. (GE Healthcare, Cytodex)

Conventional method

Micropipetter

Culture well (100 ~ 1000 Holes)

Single particle with cell

Culture solution

1. Time-consuming
2. Skill-dependent
3. Contamination

Automated single particle dispensing system is required.

Basic Concept :

Single Particle Dispensing System Kawahara et al., microTAS, 2010

① Loading and sensing ② Ejection

Reusable drive system Disposable microchip

Particle Tube Loader Sensors Nozzle

Culture well XY-stage

Air ejection

Droplet with a particle

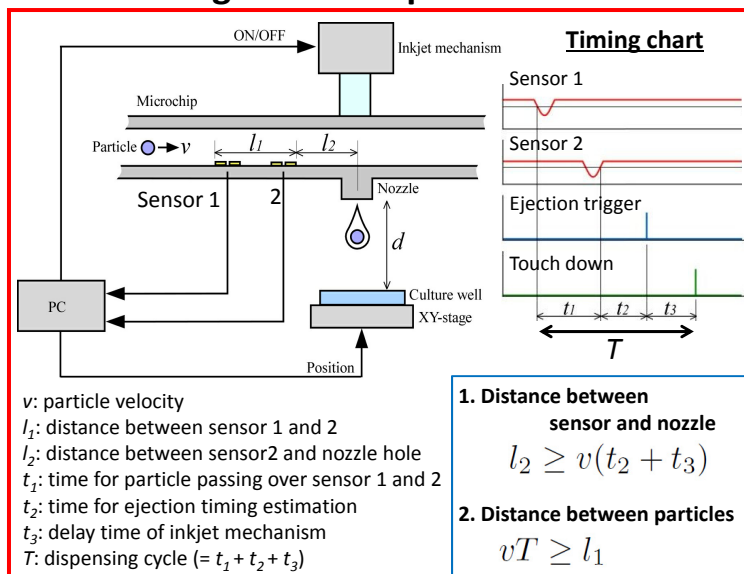
Problems:

- Low success rate (less than 5 %)
- Adhesion between cells (without loader)

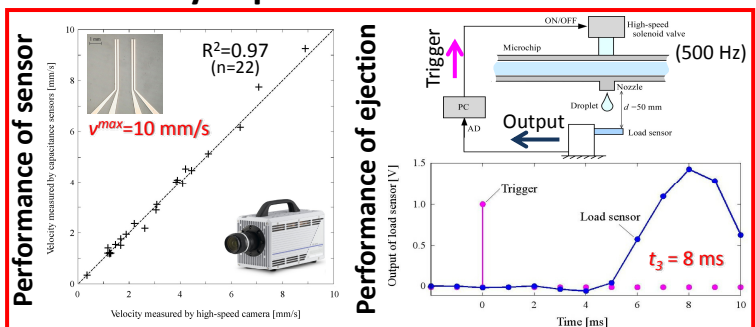
Single cell and particle dispensing ($\mu\text{-TAS2010}$, ICRA2011)

Microchip design and fabrication to increase success rate and throughput of single particle dispensing

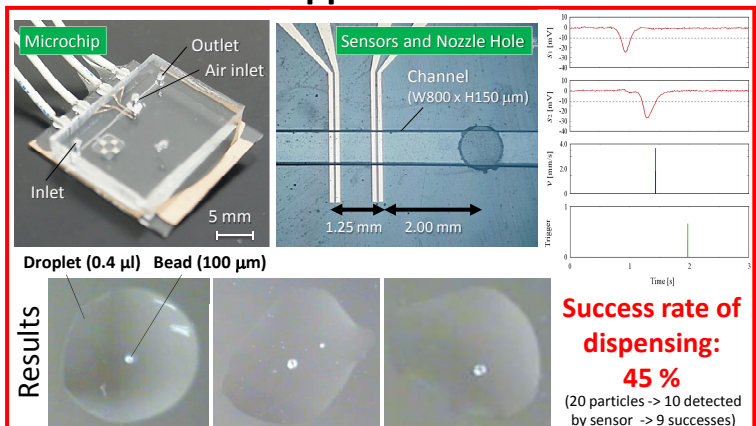
How to Design Microchip:



Preliminary Experiments:



Fabrication and Application :



Conclusion & Future Works :

- High-speed single cell dispensing system with disposable microchip.
 - 3 particles/sec throughput (theoretically)
 - 45 % success rate
- Improvement of the success rate and dispensing speed.
- Evaluation of damage of cells caused by loading and ejection.

[Acknowledgement]

This work is partially supported by JST-SENTAN, and the Nagoya University Global COE program for Education and Research of Micro-Nano Mechatronics.

[Reference] T. Kawahara et al., Advanced Robotics, 26, 3-4, 2012 (in press).

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