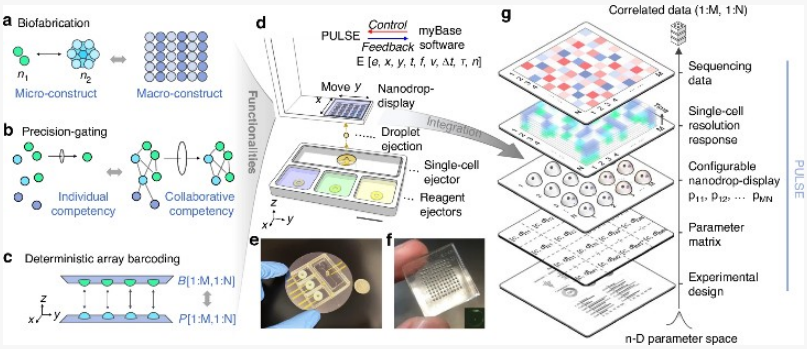
PULSE: the future of single-cell laboratory automation

GA, UNITED STATES, March 5, 2025 /EINPresswire.com/ -- A new technology called PULSE (Precise Ultrasonic Liquid Sample Ejection) is set to redefine the field of single-cell research. By harnessing ultrasonic waves, PULSE offers a highly precise, automated solution for conducting experiments at the single-cell level, enabling researchers to unlock new dimensions in biological studies. This innovative platform allows for the exact ejection of nanodrops containing individual cells or reagents, overcoming the limitations of traditional bulk-cell analyses. With unprecedented precision and scalability, PULSE promises to be a game changer in understanding cellular behavior, heterogeneity, and rare biological events, with far-reaching implications in medicine, tissue engineering, and synthetic biology.



PULSE: an acoustic-based automated single-cell-analysis platform.

While laboratory automation has revolutionized biomedical research, the challenge of performing single-cell experiments remains a significant hurdle. Traditional methods struggle to achieve the required precision and biocompatibility necessary for handling individual cells. Moreover, bulk-cell analyses often obscure valuable data due to population masking and cooperative behaviors among cells, making it difficult to obtain accurate, meaningful insights. These limitations underscore the need for new technologies capable of addressing the complexities of single-cell experimentation with minimal interference.

In a study (DOI: 10.1038/s41378-024-00798-y) published on August 17, 2024, in Microsystems & Nanoengineering, researchers from Duke University introduced PULSE as a novel solution to the limitations of current single-cell research methodologies. This breakthrough technology facilitates the precise deposition of single cells and reagents into nanodrop arrays, making it possible to conduct high-resolution biological experiments with remarkable accuracy and scalability.

PULSE represents a significant leap forward in single-cell research. The platform enables the controlled deposition of single cells and reagents into nanodrop arrays, with volumes ranging

from picoliters to microliters. Ultrasonic waves ensure a high degree of precision (90.5-97.7% accuracy) and speed (5-20 cells per second), surpassing traditional pipetting robots. PULSE's ability to handle delicate biological samples without compromising cell integrity or viability is a key advantage, allowing for more reliable and reproducible results in sensitive experiments.

The PULSE technology is versatile, supporting multiple functionalities such as biofabrication, precision gating, and deterministic array barcoding. In biofabrication, PULSE can create complex hybrid spheroids and hydrogel patterns by precisely depositing different cell types. The precision gating function allows researchers to isolate and observe individual cells, revealing heterogeneity and rare biological events within populations. Additionally, the deterministic array barcoding technique links cell behavior with genetic data, offering a direct correlation between phenotypic and genotypic information. This ability to analyze single-cell phenotypes alongside genetic data opens new avenues for comprehensive, high-resolution research.

According to Dr. Tony Jun Huang, a leading researcher on the project, "This technology represents a major leap forward in single-cell research. By enabling precise and dynamic analyses at the single-cell level, PULSE provides researchers with a powerful tool to explore complex biological systems with unprecedented resolution and accuracy."

The potential applications of PULSE span a wide range of fields. In embryogenesis, the technology can provide unprecedented control over cell development and differentiation. In tissue engineering, it facilitates the creation of intricate cellular structures with unmatched precision. PULSE also holds great promise for immunology, enabling detailed analysis of immune cell behavior and interactions. In drug screening, the platform allows for targeted drug delivery to individual cells, uncovering unique responses and resistance mechanisms. By automating single-cell experiments, PULSE enhances both the efficiency and accuracy of research, driving innovations in personalized medicine and advanced biotechnological applications. Its ability to preserve cell integrity positions it as an essential tool for precision medicine and synthetic biology, marking the dawn of a new era in cellular research.

DOI
10.1038/s41378-024-00798-y

Original Source URL
https://doi.org/10.1038/s41378-024-00798-y

Funding information
We acknowledge support from the National Institutes of Health (Grant numbers: R01HD103727, UH3TR002978, R01GM141055, R44OD024963, R44HL140800, and R44AG063643).

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