High-Precision Cell Membrane Tracking for Automated Electrophysiology (#7467)

A novel deconvolution algorithm to process electrophysiological measurements in real time using differential interference contrast (DIC) microscopy

Researchers at Georgia Tech have developed a new algorithm for identifying and tracking cell membrane locations. This has the potential to automate electrophysiological measurements such as patch clamping, the “gold standard” of single-cell electrophysiology. The procedure leverages DIC microscopy to examine in vitro brain slices. Data is processed through a novel deconvolution algorithm formulated as a regularized least-squares optimization with the goal of providing automated visual tracking of a target cell’s membrane to guide automated electrophysiology systems (e.g., robotic patch clamping systems).

Importantly, this unique process can sift through high levels of organic tissue interference and can operate in environments with moving tissue. The algorithm filters out noise in the current image and then deconvolves and segments that image to determine cell edges based on the data from images earlier in the sequence. The final stage is a segmentation based on that deconvolution, which is performed with simple thresholding.

Benefits/Advantages

- **Highly accurate**: Overcomes the challenges of tissue interference and movement for precise membrane tracking that can be used for automation
- **Instantaneous**: Surpasses earlier attempts at automating this process by effectively identifying and tracking cell boundaries in real time
- **High fidelity**: Operates efficiently and precisely even in dynamic, high-interference environments

Potential Commercial Applications

- Drug design and development
- Research tool

Background/Context for This Invention

Manual patch clamping is widely considered to be the most effective means of taking electrophysiological measurements from a single cell. Its process, however, is challenging and laborious. The potential for automating in vitro brain slice patch clamping lies in the use of microscope imagery to visually guide the membrane tracking process. DIC microscopy is one of the best methods for examining samples that are otherwise transparent, but high levels of organic tissue interference complicate its application. This Georgia Tech method uses a novel cell segmentation and boundary tracking algorithm that could automate this process in in vitro brain slices.

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More Information

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Publications

Cell Membrane Tracking in Living Brain Tissue Using Differential Interference Contrast Microscopy, IEEE Transactions on Image Processing, December 27, 2017

PatcherBot: a single-cell electrophysiology robot for adherent cells and brain slices, Journal of Neural Engineering, May 21, 2019

For more information about this technology, please visit:
https://licensing.research.gatech.edu/technology/high-precision-cell-membrane-tracking-automated-electrophysiology

Images:

The automated sequential delivery of multiple fluids. A varying number of delay gates imprinted in the branches are shown in the figure.

COVID-19 and flu saliva test on paper: (A) The automatic sequential delivery of multiple reagents required for virus test; (B) Water pouring into the device triggers the virus assay, allowing the presence of SARS-CoV-2 and influenza A & B viruses to be visually identified by the color changes in the corresponding detection spot