High-throughput, fully-automated patch clamp robot for in-vivo electrophysiology and morphology

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Introduction

Patch clamp recording is the gold standard for measuring single ion channel currents, synaptic input, and whole cell currents in neurons. However, patch clamp recordings are still somewhat of an art form requiring great skill to record from only a few cells a day. For the last 20 years, patch clamping was only performed by highly skilled technicians who have undergone months of training. Kodandaramaiah et al. recently developed a robot and neuron detection algorithm to autonomously record from neurons in vivo. This robot, called the autopatcherg, performs the skilled tasks previously performed by trained technicians and enables autonomous simultaneous recordings that have historically been extremely difficult to obtain.

The robot presented here demonstrates fully automated high-throughput patch clamping in vivo. Once the craniotomy and pipette pulling are complete, this robot takes the pipette and fits it into the headstage, threads the silver wire, positions the tip at the surface of the brain, and attempts a patch clamp trial without any human interaction. Once the trial and recording are complete, it removes the pipette from the brain and repeats the process. Aside from maintaining the craniotomy, anesthesia, or any fault handling, the robot can gather in vivo patch clamp recordings autonomously.

Precise Pipette Positioning

Hardware

Conclusions

Electrophysiology Results

Stability

- This robot performs fully automated, closed-loop patch clamping in vivo. Only a few manual setup steps remain (surgey, pulling pipettes, etc.). The robot searches for neurons in the tissue, forms the seal, breaks in, monitors the quality of the whole cell recording. Initiates the visual stimulation for this experiment, terminates the recording, removes the pipette, and repeats. This new hardware will allow one technician to operate several patch clamp robots simultaneously which will drastically increase throughput for multiple recordings in the same creature.

References and Acknowledgements