NEURAL AMPLIFIER AND SPIKE SORTER

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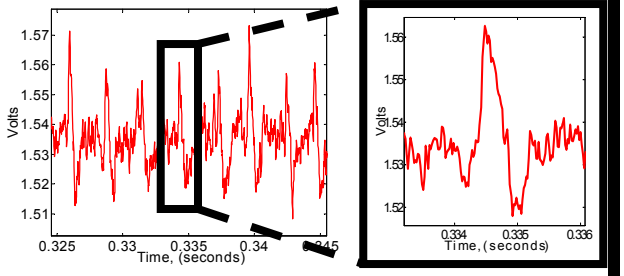
INTRODUCTION

- To understand the complex dynamics of brains, it is necessary to obtain and analyze neural data from animals exhibiting natural behaviors
- In most cases, animals need to be restrained to obtain neural recordings
- A lightweight, low-power chip is being developed to enable simultaneous recordings from large populations of neurons, sorting of the neural spikes, and wireless data transmission

WHAT IS SPIKE SORTING?

- Neurons are brain cells that transmit and receive information, and they communicate using electrical pulses, known as spikes

Neural Spike Train **Enlarged Spike**



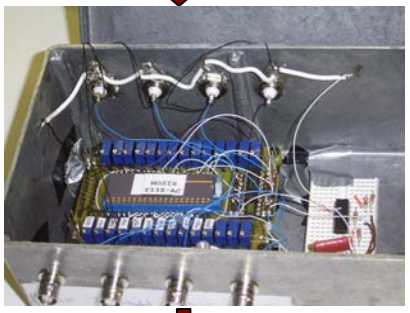
- Different neurons fire characteristic spikes that can be distinguished by features, such as amplitude, rise time, and shape
- Spike sorting uses some or all of these features to distinguish between different neurons and determine when each unique neuron fires

GOALS

- Refine methods for obtaining neural signals from live blowflies and test a prototype spike sorting chip with those real-time signals
- Analyze the circuit and adjust the biasing to obtain proper functionality

OBTAINING LIVE NEURAL RECORDINGS

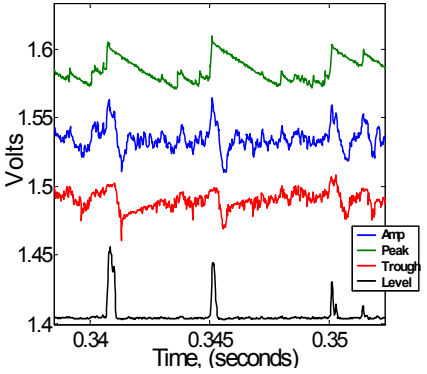
The circuit was tested by extracting neural signals from the lobula plate of blowflies



The fly was restrained with wax, and a microelectrode was inserted along with a ground wire

The signal from the fly's brain was sent to the chip, which was placed in this metal box to reduce noise

Output of Chip with Live Blowfly H1 Input

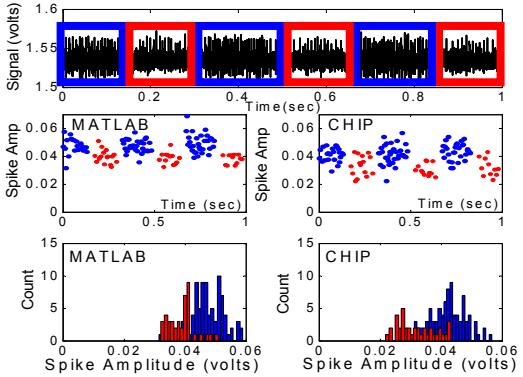


The chip produces several outputs, including an amplified signal, a peak follower, a trough follower, and a threshold level detector

By extracting these features, spike sorting can be accomplished

RESULTS

- For the first time in our lab, neural data was successfully obtained from live blowflies and fed directly to the chip. These experiments were consistently repeated.
- Chip amplifies neural signals and extracts peak and trough measurements and threshold crossings
- The chip's spike sorting capabilities have been analyzed and compared to existing algorithms



Above: Comparison of the chip's spike sorting capabilities to an algorithm in MATLAB. Red and blue represent the two different classes of neural spikes present. Spike amplitude is the difference between the peak and trough

CONCLUSIONS

- Using this chip as a building block, in the future, bulky hardware restraints can be eliminated and wireless data acquisition made possible
- With the refined process for locating blowfly visual neurons, testing of future chips can be efficiently done
- Improvements to accuracy of the measurements can be made, and additional feature detection and spike sorting can also be implemented

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