CRCNS Data Sharing

Large-scale neuronal recordings in primary visual cortex

INTRODUCTION

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Background

Although much has been learned about brain function from recording single neuron responses, some questions in computational and systems neuroscience are not amenable to this approach. Drawing elaborate conclusions about cortical circuit function or making models of network dynamics based on sequential recordings from one or two neurons at a time is not sufficient. This was my motivation for designing several multi-channel silicon electrode arrays, or 'polytrodes', which are capable of recording simultaneously from more than 100 well-isolated single units spanning the cortical layers (Figure 1).

Polytrodes were used to record neural activity in anesthetized, paralyzed cat and awake macaque primary visual cortex. Both spontaneous and visually-evoked responses were recorded. The database contains responses to a wide range of visual stimuli, including: sinusoidal drifting gratings of differing orientation, spatial and temporal frequency, and contrast; spatiotemporal noise stimuli generated with varying statistics; flashed spots, bars and gratings; and dynamic natural scene movies (Figure 2). A subset of these data are being made available as part of the CRCNS Data Sharing Initiative.

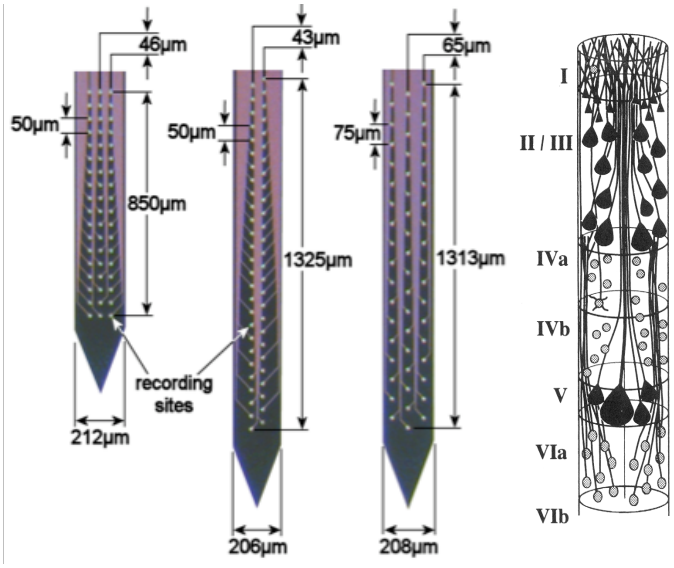

Figure 1 Dimensions and recording site configurations of three 54-channel polytrodes developed for high-density sampling of neurons within and across cortical columns.

Several unique aspects of these data should be emphasized:

(i) the polytrode was not moved during the entire set of visual stimuli at a single penetration location, so the sample was not biased by the experimenter's decision to study a particular cell (as is the case with conventional single unit recordings, where there is likely a bias towards recording neurons with the largest spike amplitudes or those that are most visually responsive);
(ii) functional measures, such as receptive field properties, can be put in the context of the anatomical structure of the cortex, as the absolute position of each recorded neuron in the cortical layers can be estimated precisely;
(iii) since it was routinely possible to obtain stable recordings for several hours, individual neural populations could be characterized with a wide variety of visual stimuli in a less biased manner (i.e. an exhaustive set of parametric stimuli were presented instead of a subset of 'optimal' stimuli for one neuron);
(iv) identical (or comparable) stimuli were presented in both cat and monkey experiments, enabling a direct cross-species comparison of response properties and the potential to explore the generality of any findings.

At the same time these data build upon a long tradition of visual neurophysiology started by Hubel & Wiesel in the 1950's. Experiments with controlled stimuli like oriented bars, flashed spots of light, and drifting sinusoidal gratings, can not only be used to map classical receptive field properties, but also provide a framework for interpreting the more specialized data obtained with dynamic natural scene stimuli.

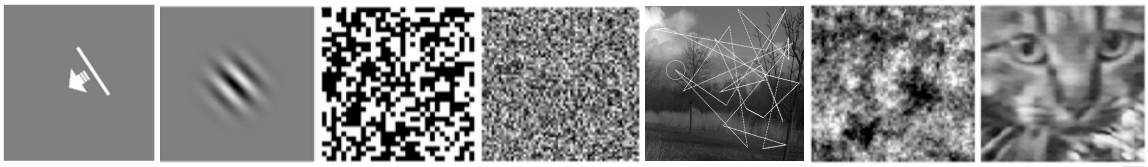

Figure 2 A sample of the set of visual stimuli used to characterize neuronal responses. From left to right: oriented drifting bar; sinusoidal grating patch; m-sequence white noise; Gaussian white noise; simulated saccade movie; spatiotemporal pink noise; and dynamic natural scene movies courtesy of Peter König (www.ini.uzh.ch/~peterk/ProjectFrameset.html). Scale = 1.5 deg.

Data overview

The shared portion of these data have been grouped into two datasets:

Dataset 1: Multi-neuron evoked responses in primary visual cortex

- spike times of ten (10) simultaneously recorded cells from a single penetration in anaesthetized cat area 17 in response to oriented drifting bars, spatiotemporal white noise, and a dynamic natural scene movie.
- spike times of ten (10) simultaneously recorded cells from a single penetration in awake monkey V1 during a fixation paradigm, in response to stimuli comparable to the cat experiments.
- 2D eye tracking data in the case of the monkey recording.
- code and movie frames for re-generating the stimuli, and stimulus meta-data.
- additional meta-data detailing the experimental setup, data acquisition, signal processing, spike sorting, etc.

Dataset 2: Multi-neuron spontaneous activity in visual cortex

- spike times of 25~50 simultaneously recorded neurons, from two recordings in cat (areas 17 and 18) and monkey primary visual cortex, ~200 neurons in total.
- 2D eye tracking data in the case of the monkey recording.
- additional meta-data detailing the experimental setup, data acquisition, signal processing, spike sorting, etc.

Potential uses

These data could be used to study micro-scale receptive field (RF) organization as it relates to cortical anatomy; to explore the neural mechanisms that give rise to these RF tuning properties; and to test explicitly a range of hypotheses regarding population coding in the primary visual cortex. More generally these data could be used to study the statistics of cortical activity and neural sparseness; and explore cortical dynamics by analyzing the inter-relationships between spike timing and multi-channel local field potential (LFP) data.

Another potential use for these data is evaluating the performance of new or existing spike sorting algorithms since the unprocessed, continuously sampled waveforms contain many examples of spikes that are unequivocally single units (with signal on 8~15 recording sites). The assortment of spike shapes and amplitudes would provide a rigorous test of any algorithm. For physiologists interested in the nature and origin of extracellular action potentials the high resolution spatial 'image' provided by these multi-channel spike waveforms should be of interest.

Getting started

Download the data from the CRCNS website and read the `users_guide.pdf`.

Terms of Use

These data are provided free of charge and without warranty. There are no restrictions placed on its use, however if the data are used in a published academic work or for teaching purposes, both the Data Sharing Initiative and the relevant laboratory where the data were obtained must be cited in the Methods or Acknowledgement section. For the cat data, the appropriate attribution is: *Neural data were recorded by Tim Blanche in the laboratory of Nicholas Swindale, University of British Columbia, and downloaded from the NSF-funded CRCNS Data Sharing website*. For the monkey data, the appropriate attribution is: *Neural data were recorded by Tim Blanche in the laboratory of Winrich Freiwald, University of Bremen, and downloaded from the NSF-funded CRCNS Data Sharing website*.

References

Blanche TJ, Spacek MA, Hetke JF, Swindale NV (2005) Polytrodes: high density silicon electrode arrays for large scale multiunit recording. *J. Neurophys. 93 (5): 2987-3000*.

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