IMPROVING NEURAL PROSTHETIC SYSTEM PERFORMANCE FOR A FIXED NUMBER OF NEURONS

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The performance of neural prosthetic systems can be improved by increasing the number of neurons used, developing better decode algorithms, or increasing the amount of model-fitting data. Although increasing the neuron count has been the principal approach, there is a practical limit to the number of neurons that can be obtained. To further increase decode performance, we assessed the benefits of employing the other two strategies.

We investigated point-to-point reaches in a delayed center-out task. We recorded from the dorsal pre-motor cortex (PMd) of a macaque monkey during reaches to visual targets at 10 different distances along a line (30 to 120 mm in each direction). Most PMd neurons emitted action potentials during both the delay period (*plan activity*) and the movement period (*peri-movement activity*). We recently proposed a decode algorithm that incorporates both plan and peri-movement activity. Here, we apply this idea to neural data and show how to improve performance for a fixed number of neurons.

We considered three decode algorithms, all of which employ maximum-likelihood classification with Gaussian data fitting. The first fits a Gaussian to the distribution of firing rates averaged over a single window that includes both the plan and movement periods (*Undifferentiated Rate*). The second estimates firing rates in the plan and movement periods separately (*Plan Rate / Move Rate*). The third is based on plan firing rate and the first principal component of the peri-movement spike train (*Plan Rate / Move PC*).

We found the average distance error between the true and estimated reach targets to be 15.8, 14.6, and 13.3 mm, respectively, for the three algorithms above using 20 neurons and 19 model-fitting trials per reach distance. By differentiating between the plan and peri-movement periods and by taking into account the time-varying structure of peri-movement activity (*Plan Rate / Move PC*), we obtained a 16.3% improvement in performance compared with *Undifferentiated Rate*. Furthermore, we found a 31.2% performance difference for *Plan Rate / Move PC* between training set sizes of four and 19.

Our results show that, even with a fixed neuron count, decode performance can be significantly improved by combining information from the plan and movement periods. The amount of training data is also an important, and possibly limiting, factor. Taken together, these ideas should enable higher-performance neural prosthetic systems for any fixed number of neurons.