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RECONSTRUCTION OF ARM TRAJECTORIES FROM PLAN AND PERI−MOVEMENT MOTOR CORTICAL ACTIVITY

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A variety of methods for decoding the trajectory of the arm from peri−movement neural activity have been described. Also, it has been shown that plan activity encodes the endpoint of an impending reach. Since many neurons in motor cortical areas display both types of activity, an efficient prosthetic interface might use both to improve its estimate of the arm's trajectory. We have developed a decoder based on this concept that achieves significant performance gains. We trained a rhesus monkey to perform a center−out delayed−reach task. Neural activity was simultaneously recorded from 111 single− and multi−neuron units on a 96−channel electrode array in the dorsal pre−motor cortex. To relate the endpoint of a reach to its trajectory over time, a model of reaching movements is required. We estimated endpoint−dependent stereotype reaches from training data. We fit models of the endpoint tuning of the units in both the plan and peri−movement periods, as well as the velocity tuning of units based on their peri−movement activity. To reconstruct a given reach, a running estimate of the endpoint is formed. Concurrently, the reach−model, along with the velocity−tuning model, converts this target estimate into a running estimate of the arm's position. With peri−movement activity alone, our decoder reduced mean−square error by 68% and 65% compared to a traditional linear filter (10−tap, 25 ms bins) and a Kalman filter (which permitted spikes to be related to up to 250 ms of future movement), respectively. The combination of plan and peri−movement activity yielded further improvement (5% and 6%); when fewer units are available, the addition of plan activity has even greater benefit.

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