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A model of free monkey scribbling based on the propagation of cell assembly activity

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Recent findings on a free scribbling task in monkeys [1] reveal that planar trajectories can be decomposed into elementary movements. Typical patterns in the experimental data are parabolic segments that correspond to piecewise constant acceleration of the end effector. We present a biologically plausible spiking neuronal network model of free monkey scribbling that maps accelerations to positions via a representation of velocities, where the unperturbed propagation of synchronous activity represents a parabolic segment. The control architecture can be visualized as a graph in velocity space: vertices correspond to constant velocities and are connected by edges that correspond to constant accelerations. The edges are formed by synfire chains (SFCs) [2] that transform the trajectory velocity linearly between the start and end vertex: local neuronal groups code a velocity that depends on its position along the edge. A trajectory is generated by integrating the population vector of all neurons. The neurons in the network are driven by independent Poisson input such that in the absence of synfire activity, an asynchronous irregular dynamic state is maintained. Activity in the final group of a SFC can activate the first group of any SFC whose start vertex coincides with the end vertex of the previously active chain, thus changing the direction of acceleration. Reliable switching to select one of several candidate SFCs with the same start vertex is achieved by mutual inhibition among the SFCs. The scribbling activity is sustained by a background network of highly recurrent backward and forward connected chains (BFCs). Self-ignition from the background activity initiates synfire activity in the model. The activity of the BFCs is suppressed during active scribbling. The assumptions of the model are derived from a perceptual, rather than a muscular, control approach. The model provides an explanation for the segmentation of the trajectory [1] and guarantees on-going parabolic movement trajectories with smooth transitions and an end-effector dynamics that obey the experimentally observed two-thirds power law [3].

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References

1. Polyakov F, Stark E, Drori R, Abeles M, Flash T: **Parabolic movement primitives and cortical states: merging optimality with geometric invariance.** *Biol Cybern* 2009. doi: 10.1007/s00422-008-0287-0.
2. Abeles M: *Corticonics: Neural Circuits of the Cerebral Cortex Cambridge University Press*; 1991.
3. Viviani P, Flash T: **Minimum-jerk, two-thirds power law, and isochrony: converging approaches to movement planning.** *J Exp Psychol Hum Percept Perform* 1995, **21:**32-53.
4. Gewaltig M-O, Diesmann M: **NEST (NEural Simulation Tool).** *Scholarpedia* **2:**1430.