THE COINCIDENT REDUNDANT MULTIPLEX: THE CODE OF THE BRAIN

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Abstract

The coincident redundant multiplex (CRM) theory based on information analysis of the coding and transmission of information in the biological neural nets has been successfully tested on two techical models. The main principle of CRM is a hologram interference of redundant impulses.

CRM can reduce the number of connection lines in the neural computers, create active memories and offer a basis for a new kind of eye, hearing and muscular prothesis.

A Parametric Model for Synthesis of Cortical Column Patterns

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ABSTRACT

A common property of mammalian cortex is that cells with related response properties tend to be spatially localized. Such regions often take the form of irregular stripes or blobs; patterns of these types are said to have *columnar* structure. We introduce a parametric model for columnar structure which considers the spatial form in an image-processing framework. This method permits easy synthesis of column-like structure from noise images. In particular, bandpass filtering of noise images followed by thresholding yields patterns which strongly resemble the columnar structure which has been observed in the brain. The image-oriented technique is flexible and inexpensive to compute. There are only a few independent parameters, and the role they play in column formation is apparent. The parameters for a particular column system can be readily determined from actual brain data by the use of standard image-processing techniques; we have used the model to process data obtained in our own computer reconstruction of the pattern of ocular dominance columns in the macaque monkey. Our approach avoids the necessity of constructing computationally expensive cellular models which are based on poorly understood details of neural development. We provide an efficient, accurate model which can be adjusted to fit a wide variety of column data.

AN IMPLEMENTATION OF THE EQUILIBRIUM TRAJECTORY HYPOTHESIS FOR MOVEMENT GENERATION IN THE ARM*

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Abstract

A mathematical model of the neuromuscular system is built to describe some of the consequences of the Equilibrium Trajectory Hypothesis (ETH) regarding the role of spinal control structures in movement. This model builds on the assumption that the spring-like reaction of the arm to small disturbances is mainly due to the length-tension properties of the muscles and not the length dependent spinal reflexes. In order to explore point to point movements, a two joint model of the arm is constructed and its inverse dynamics are solved to predict movement trajectories for developed muscular forces. ETH suggests that movement is controlled by the CNS through gradual shifting of the arm's equilibrium point. A minimum jerk criterion function is used to define this virtual trajectory. Since ETH defines the virtual trajectory only based on kinematics, it appears to be ill-suited for assigning neuronal activation rates: such a program must also take into account the nature of the task, e.g., the stability of the system in motion. An algorithm is suggested for assigning firing rates for a given virtual trajectory. Since we wish to determine the role of the spinal reflexes, we test the model in the case where no afferent information is available, hence the virtual trajectory serves as the only source of neuro-muscular activation. The deafferented arm is never-the-less capable of reaching the goal, although its time for completion of the task is much longer. The deafferented arm's trajectory deviates widely from the desired trajectory, therefore it is suggested that a consequence of the ETH is that the spinal reflexes must alter neuronal firing rates to minimize this error. Required structure of such a control system and its subsequent comparison with physiological data can serve as a test of the ETH.