SEMINAR NOTICE

Department of Electrical and Systems Engineering

Dynamics of the Turtle Visual Cortex
And Design of Sensor Networks

by

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Extracellular recordings and experiments with voltage sensitive dyes have established the fact that the visual cortex of freshwater turtles produces waves of activity as a result of an input pattern of visual activity. A large-scale model of the turtle visual cortex has been constructed that has the ability to simulate waves with the same qualitative features as the cortical waves seen in experimental preparations. The model contains five populations of neurons: lateral pyramidal and medial pyramidal cells (excitatory cells); stellate, horizontal and subpial cells (inhibitory cells). With the detailed compartmental model of subpial cells and the large scale model, the biophysical properties of subpial cells were examined and it is indicated that the responses of subpial cells to simulated visual stimuli consist of two phases. A fast phase is mediated by direct geniculate inputs. A slow phase is mediated by recurrent excitation from pyramidal cells. It appears that subpial cells play a major role in controlling the information content of visual responses. Visual stimuli produce waves of activity that propagate across the visual cortex. The model of visual cortex was used to study the roles of specific types of cortical neurons in controlling the formation, speed and duration of these waves by systematically varying the maximal conductances of each receptor type postsynaptic to each population of neurons. The analyses indicate that wave formation and speed are controlled principally by feed-forward excitation and inhibition, while wave duration is controlled principally by recurrent excitation and feedback inhibition.

It is believed that waves of activity produced by the large scale model of turtle visual cortex with visual stimuli encode visual information. We address how images of objects as natural inputs are represented using a sparse coding strategy with an over-complete set of basis functions and subsequently how the codes are fused to produce a data stream of vectors. Principal component analysis (PCA) is used for information fusion. Then the encoded data stream is internally represented by the neural network that works as a wave generator. The activity wave, so generated, can be used to decode various features from the visual space, viz. location and velocity of moving targets. It can also be used to discriminate one scene from another. The Hypothesis Testing algorithm can be used to distinguish between the three scenes. As an alternative scheme, linear Autoregressive Moving Average (ARMA) models are used to estimate input to the cortex model. By estimating input to the cortex one can reconstruct salient features of visual inputs, viz. velocity and positions of targets. We also propose a pattern detection technique using neurocomputational features of weakly connected neural networks of oscillators. A set of memorized patterns are associated with the prescribed equilibria in phase relations of oscillators. The equilibria in phase relations of the oscillatory network are prespecified with connection matrices and Kuramoto's model is used in designing these equilibria. The neurocomputation of Kuramoto's model could be implemented by optical devices, an array of coupled lasers.

DATE:	Thursday, July 6, 2006
TIME:	11:00 a.m.
PLACE:	Room 305, Bryan Hall

Research Advisor:
Bijoy K. Ghosh

This seminar is in partial fulfillment
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Washington University in St. Louis
School of Engineering & Applied Science