Chemical information processing with excitation pulses

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position statement for
The Grand Challenge in Non-Classical Computation Workshop

April 18, 2005

1 Introduction

Spatially distributed chemical excitable systems can work as information processing media in which information is coded in pulses of excitation [1, 2, 3, 4]. In some cases, like for example in the search for the optimum path in a labyrinth, the galgorithmsh used by a chemical medium is the most efficient. Feeling links between the processes of thinking in living organisms and the properties of interacting pulses in simple chemical systems we do research in the field.

2 Present stage

At the moment it is commonly assumed that a chemical signal is composed of excitation pulses. The information can be coded in the number of pulses or in the sequence of time differences between the consecutive pulses. Although the difference is very basic, it does not influence research at its present stage. Regardless of the method of coding we have to learn how to transform a signal using chemical "tools": reactions and diffusion of reagents. At the moment it is quite common to work with media that have non-trivial geometrical structures - they are composed of active regions where pulses propagate and passive parts where excitations rapidly decay. Using such nonhomogeneous media one can built devices that perform logical operations on the signals, check signal frequency or count the number of pulses arriving at a given point [5]. Interesting recent results [6] demonstrate that a chemical system

can gsenseh both the distance separating it form the source of excitations and the direction from which excitations are coming.

3 Future

There are a number of problems that seem important for the future progress of chemical information processing. Among them we would list:
- the use of more sophisticated models of chemical medium and complex geometrical distribution of chemical properties in space. Most of theoretical studies are based on simple models of excitability (Fitz-Hugh - Nagumo, Oregonator) that give results valid for in general. However, it comes out that if one uses more specific model of excitable system (like for example the model for CO/Pt surface oxidation) than new types of behaviour, important for information processing are observed.
- the construction of fast and reliable chemical memory. At the moment a wave on a ring is used as the basic memory cell [7], but such realization of memory is slow and occupies a lot of space. We hope the specific spatiotemporal effects observed in more complex models of nonlinear reaction-diffusion systems (like, for example, oscillons) can be used as a memory.
- the experimental realization of chemical neural networks. Having a chemical memory we can construct switchable signal channels and so we are able to control the structure of connections within a network of neurons (a chemical analog of McCulloch Pitts neuron can be easily realized). Thus it seems that all the elements for a simple chemical neural network are available.
- establishing the link between chemical information processing and other spatiotempotral phenomena like self-replication or self-organization. If it is successful one can think about chemical signal processing devices that are able to repair themselves when damaged or that can grow in time and perform more complex tasks.

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