鉄道	車
カオス	?
民主主義	? ?

Cybernetic Measurement and Control of Coherence

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My contribution to this session on chaos and evolution is to point to some challenging non-linear dynamical problems which arise when we try to replace the chaos researcher with appropriate dynamics.

I have been interested in the significance of quantum and classical complex dynamics for coherence in optical measurement, control and computing systems. I would like to use the example of phase-locking dynamics to suggest four issues in non-linear dynamics which I think are important and interesting problems for the future.

Consider the model of a non-linear measurement/control device in figure 1. A signal Si is input for a non-linear dynamical element Fs which is specified by parameters P. An output signal So is characterized by a quantity Q This characterization involves comparison at Fq with a reference Ro derived from an input reference Ri.

When Si is an oscillatory signal and Fs is a non-linear oscillator or resonator, phase-locking dynamics are important for the stability and coherence of So. A feature of phase-locking dynamics is sensitive dependence on parameters (SDP) - this can be ordered SDP as for example when locking occurs at all commensurate winding numbers on the two-torus, or disordered SDP when locking frustration occurs, for example with the breakup of the two-torus or on the surface of higher-dimensional tori.

The first issue is quantification Q of dynamical states which takes into account finite resolution in system specification and signal observation. Developing methods to relate measure and magnitude of chaos to signal coherence in an experimentally meaningful sense is particularly important for systems which have sensitive dependence on parameters.

The second issue is the variational dependence of this quantification Q on system specification and observation parameters P. When there is a disordered sensitive dependence on parameters the function Q(P) may be complex.

The third issue concerns parameter dynamics and the implications for cybernetic control when feedback at Fp from system measurement Q to parameter specification P is used to drive the system to a specified objective state and hold it there. Complex variation with parameters can result in control frustration. Overcoming this type of control frustration to attain the objective system state demands global knowledge of parameter space. The challenge is to develop a dynamics of control parameter space in which functions Fq, Fp and Fs are recorded in a dynamical memory.

The fourth and last issue is more speculative but relates to issues of cybernetic measurement and control in biological systems - the generation by a cyber of its own sense of "order" or "coherence", ie. allowing the control system to define the objective state itself. One approach is to generate Ro from Si with a dynamically modifiable method Fr.

These problems in non-linear dynamics arise from the conventional cybernetic approach of progressively replacing specification P, reference R and measurement Q tasks of the system designer by appropriate dynamics. Measurement and control of complex resonance structure in low dimensional phase dynamics is an appropriate challenge for such an evolving system.

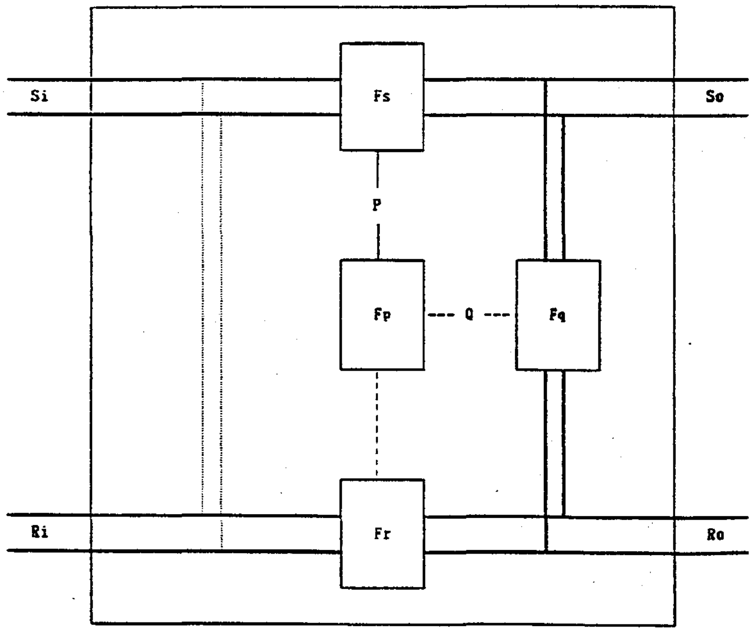

Figure 1.

カオスから脳の科学へ

新技術開発事業団　津 田 一 郎

今後のカオス研究はどのような方向へ発展可能であるかということに対する一つの切り口を与えるよう努めた。

講演は以下の５つの部分から構成された。

1．Chaos から生成される諸概念・諸問題

2．脳の情報力学過程　　心理＆生理，解釈，方法論

3．新しい dynamics は必要か？