Kybernetika

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Special issue: Editorial [Chaos Theory and Technology]

Kybernetika, Vol. 44 (2008), No. 4, 453--454

Persistent URL: `http://dml.cz/dmlcz/135864`

KYBERNETIKA — VOLUME 44 (2008), NUMBER 4, PAGES 453 – 454

SPECIAL ISSUE: EDITORIAL

Chaos theory and technology are promising with significant impacts on many novel, time- and energy-critical engineering applications, such as high-performance circuits and devices (e. g., signal modulators and power converters), secure information processing, biological systems (e. g., the brain and heart), liquid mixing, chemical reactions, crisis management (e. g., in power systems), and artificial intelligent decision-making in industrial, economic, as well as military automation networks and systems. This exciting and yet challenging research and development area has continuously been a scientific inter-discipline involving systems and control engineers, theoretical and experimental physicists, computational and applied mathematicians, biologists and physiologists, and electronics specialists, among others.

There are many practical reasons for studying and utilizing chaos. In a system where complex responses are undesirable or harmful, chaos should be reduced as much as possible or even totally eliminated. This situation demands such tasks as to avoid fatal voltage collapse in power grids, to suppress deadly cardiac arrhythmias, to guide disordered circuit arrays (e. g., multi-coupled oscillators and cellular neural networks), to regulate the dynamical behaviors of some mechanical and electronic devices (e.g., diodes, laser machines, and machine tools), and to organize a multi-agent corporation toward globally cooperative performance.

On the other hand, chaos can actually be quite useful for some real-world applications. In fact, there are increasing interests in utilizing the very nature of chaos, particularly in some novel time- and energy-critical applications. A salient feature of chaos is that it has a special property known as ergodicity that can enable a system to explore its every dynamical possibility. When chaos is under control, it can provide the system designer with a variety of attractive properties and a great deal of flexibility, as well as a cornucopia of opportunities. For example, it has been shown that the sensitivity of chaotic systems to small perturbations and parameter variations can be used to rapidly direct system orbits to desired targets consuming a minimal amount of control energy. This may be crucial for those energy-critical applications. An purposeful manipulation of the chaotic dynamics may help increase the security of data encryption and the coding/decoding efficiency in signal-image communications.

Fluid mixing is another good example in which chaos is not only useful but actually very desirable. To thoroughly mix together two fluids while minimizing the time and the consumed energy, the goal turns out to be much easier to achieve, at least in theory, if the particles' motion dynamics are strongly chaotic; otherwise, it has been well known that obtaining thorough mixing is generally very difficult due to the existence of invariant two-tori in the flow. Chaotic mixing also has beneficial applications in heat transfer, such as in plasma heating within a nuclear fusion reactor, where the best result can be obtained if the convection inside the reactor is chaotic.

For biological systems, data measurement in the form of chaotic time series is not uncommon. Evidence has shown that chaos may be an essential background mechanism employed by the human brain in carrying out many of it tasks. In addition, some clinical studies reveal that the complex dynamics in some physiological systems demonstrate several significant features and characteristics reminiscent of chaos.

Motivated by many potential real-world applications, the current research on chaos theory and technology, including its analysis, control, synchronization, generation and circuit design, etc., has significantly proliferated in recent years. As it turns out, research on the chaos-based technology is truly inter-disciplinary, which involves comprehensive and extensive knowledge of cross-subjects from engineering, mathematics, physics, biology, computational science, and even sociology alike. The progress has been very promising to date.

To promote this stimulating and fast-developing research field of chaos-based technology in the Asia–Pacific region, the Four Asia-Pacific Workshop on Chaos Control and Synchronization, joint with the First Chinese Forum on Chaos Applications, was held in the Heilongjiang University, China, on August 24–26, 2007. In this joint conference, more than 80 research papers from the Asia–Pacific region were presented. Among these presentations, research topics include halo-chaos control, chaos-based signal and image encryption, multi-scroll chaotic attractors generation and circuit implementation, UWB chaotic communication systems design, various chaos control and synchronization techniques and realizations, to mention just a few. These wide-scope subjects reflect the prosperous research activities on chaos-based technology in the Asia–Pacific region especially in China. After careful reviews, some selected papers from the conference presentations are published here in this special issue of the journal.

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Guest Editors