Dynamical systems with multiple attractors: from design to applications

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Coexisting attractors in the phase space allow to switch between different dynamical behaviors without changing the parameters of the respective dynamical system. Multistability has recently received growing attention [1], yet there are no general design and controlling schemes which would enable the construction of systems with a predefined number of attractors in arbitrary phase space dimensions and the reliable switching to the desired motion pattern.

Here we present a mechanistic design procedure based on the construction of potential functions characterized by a given number of local minima [2]. By introducing a generalized friction term one can create stable fixpoint, limit cycle and chaotic attractors at specified locations of the phase space.

As an application of multistability we consider robotic locomotion arising by the stabilization of self-organized limit cycle and chaotic attractors in the combined phase space of the controller, body and environment [3,4]. Due to the symmetries of the system, several attractors corresponding to different motion primitives may coexist. Using a simple pulse-like signal we are hence able to kick the phase point to the basin of attraction of a coexisting attractor, leading for example to the reversal of direction during locomotion.

References

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