Designing Hyperchaotic Cat Maps With Any Desired Number of Positive Lyapunov Exponents

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Abstract

Generating chaotic maps with expected dynamics of users is a challenging topic. Utilizing the inherent relation between the Lyapunov exponents (LEs) of the Cat map and its associated Cat matrix, this paper proposes a simple but efficient method to construct an n-dimensional (n-D) hyperchaotic Cat map (HCM) with any desired number of positive LEs. The method first generates two basic n-D Cat matrices iteratively and then constructs the final n-D Cat matrix by performing similarity transformation on one basic n-D Cat matrix by the other. Given any number of positive LEs, it can generate an n-D HCM with desired hyperchaotic complexity. Two illustrative examples of n-D HCMs were constructed to show the effectiveness of the proposed method, and to verify the inherent relation between the LEs and Cat matrix. Theoretical analysis proves that the parameter space of the generated HCM is very large. Performance evaluations show that, compared with existing methods, the proposed method can construct n-D HCMs with lower computation complexity and their outputs demonstrate strong randomness and complex ergodicity.

Keywords

Author Keywords: Cat map; Cat matrix; chaotification; hyperchaotic behavior; Lyapunov exponent (LE)

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