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Applications of Two-dimensional Parameter-induced Stochastic Resonance in Nonlinear Image Processing

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Summary

Stochastic resonance is a mechanical concept and may be used to image processing. This paper aims to develop an elementary theory of two-dimensional parameter-induced stochastic resonance (PSR) in order to contribute a new approach to nonlinear image processing. For tackling applications of stochastic resonance (SR) in image processing where adding noise may not be an easy task, we propose to generalize the concept of parameter-induced stochastic resonance from the one-dimensional case to the two-dimensional case. Specially, a novel two-dimensional system which demonstrates the feature of parameter-induced stochastic resonance is proposed for nonlinear image processing. An interesting feature of this paper is that a rigorous analytical framework is developed based on the Fokker-Planck Equation. An application to image processing is performed to demonstrate the effectiveness of the approaches based on the theory of two-dimensional PSR. Several examples are shown to express its superiority upon traditional linear filter, especially when noise intensity is large. In general, the proposed 2D-PSR method can achieve lower BER, while holding more detailed characteristics than a low-pass filter. Just because 2D-PSR and traditional linear filters are complementary, output can be evidently improved by combining these two methods. When additive noise is Non-Gauss, 2D-PSR, due to its robustness, will perform much better than linear filters. It is believed that the PSR-based methodology as advocated in this paper provides a different, but promising, perspective for applying SR techniques to nonlinear image processing.

keywords: Image Processing, Nonlinear System, Stochastic Resonance

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