Title:	Results in Stochastic Resonance with Applications
Author(s):	Jain, Garima
Supervisor(s):	Venkatesh, K S
Keyword(s):	Stochastic Resonance, Image Standardization Image Enhancement, Denoising
Subject(s):	Image Processing
Abstract:	Conventionally, noise is thought to be a nuisance that deteriorates the performance of a system. Stochastic resonance (SR), on the contrary, is a phenomenon observed in nonlinear systems wherein the noise works favorably towards the transmission and detection of an information-carrying signal. This counter-intuitive phenomenon has been reported in a large variety of nonlinear systems, including electronic circuits, optical devices, neuronal systems, material-physics phenomena, chemical reactions, and attempts have been made to explain it. This thesis explores some of the as yet poorly understood ramifi cations of stochastic resonance and their effects in image and speech signal processing. We discuss and improve the existing algorithms for image enhancement: image denoising and contrast stretching, using stochastic resonance. We propose a localized implementation of non-dynamic and dynamic stochastic resonance. We also propose a novel SDSR (Suprathreshold Dynamic Stochastic Resonance) method for image enhancement. All the proposed approaches have been tested on large image datasets and validated with improvement in PSNR, contrast enhancement factor, color enhancement factor and perceptual quality metric. Finally, we explore the use of stochastic resonance phenomena for the estimation of image noise model using the four distributions, Gaussian, Uniform, Rayleigh and Gamma. Motivated by the capabilities of stochastic resonance in the image processing domain, we investigate its effectiveness in speech signal enhancement. Its implementation in the DWT domain results in an improved signal-to-noise ratio (SNR). We fi nally design and implement an image standardization system application for use in entrance exam forms, visa application forms, etc, where there is a constant need to ensure the acceptability and fidelity of submitted face and signature biometric data. This involves the development of a protocol that allows the use of a carefully selected reference template image that is widely available in the public domain. This leads to the successful realization of a complete system that uses many conventional techniques such as histogram speci fication and face detection, supported by stochastic resonance preprocessing for contrast enhancement. The images are evaluated using SSIM metric, and consistent performance improvements are noted.

Figure 3.2: Sample Input Image

Figure 2.10: Input Noisy Image

Figure 3.1: Reference Image