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Application of Markov random fields in image restoration

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Image restoration has been a popular field for decades. Images are destroyed when exposed to 'noise' which can occur due to physical contact or electrical/ electronic interference. In this study, Bayesian statistical technique and Markov random field (MRF) theory were used to restore a black and white binary image corrupted by additive Gaussian noise with zero mean and constant variance. The binary image was used as a Markov random field. An image is comprised of pixels and these pixels have a regular two-dimensional lattice structure. A matrix including ±1 values was generated randomly. It was used as an Ising model (±1) in Statistical Mechanics. The Ising model (±1) under Markov property was used as the Ising prior (a Gibbs or Boltzmann distribution) which is the prior distribution of Bayesian technique. Likelihood function was obtained by using the random matrix and the observed corrupted image. Markov Chain Monte Carlo (MCMC) method was used to simulate posterior distribution which again turns out to be a Gibbs or Boltzmann distribution. More specifically, Metropolis-Hastings algorithm which is one of the popular MCMC algorithms was used in this simulation. In this study Peak Signal to Noise Ratio (PSNR) and Mean Squared Error (MSE) methods were used to measure the quality of restored images. MATLAB (R2013a (8.1.0.604)) has been used to construct the program in this research work. When noise was increased the restored-image quality was decreased. When image size was increased a higher number of iterations were required to obtain an acceptable level of quality in the restored image.

Keywords: image restoration, Markov random field, Ising model, Markov chain Monte Carlo and Metropolis-Hastings algorithm

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