

Adaptive Image Restoration: Perception Based Neural Network Models and Algorithms

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Abstract

This thesis describes research into the field of image restoration. Restoration is a process by which an image suffering some form of distortion or degradation can be recovered to its original form. Two primary concepts within this field have been investigated.

The first concept is the use of a Hopfield neural network to implement the constrained least square error method of image restoration. In this thesis, the author reviews previous neural network restoration algorithms in the literature and builds on these algorithms to develop a new faster version of the Hopfield neural network algorithm for image restoration. The versatility of the neural network approach is then extended by the author to deal with the cases of spatially variant distortion and adaptive regularisation. It is found that using the Hopfield-based neural network approach, an image suffering spatially variant degradation can be accurately restored without a substantial penalty in restoration time. In addition, the adaptive regularisation restoration technique presented in this thesis is shown to produce superior results when compared to non-adaptive techniques and is particularly effective when applied to the difficult, yet important, problem of semi-blind deconvolution.

The second concept investigated in this thesis, is the difficult problem of incorporating concepts involved in human visual perception into image restoration techniques. In this thesis, the author develops a novel image error measure which compares two images based on the differences between local regional statistics rather than pixel level differences. This measure more closely corresponds to the way humans perceive the differences between two images. Two restoration algorithms are developed by the author based on versions of the novel image error measure. It is shown that the algorithms which utilise this error measure have improved per-

formance and produce visually more pleasing images in the cases of colour and grayscale images under high noise conditions. Most importantly, the perception based algorithms are shown to be extremely tolerant of faults in the restoration algorithm and hence are very robust.

A number of experiments have been performed to demonstrate the performance of the various algorithms presented.