ABSTRACT

Digital Image Processing, developed during the last three decades, has become a very important subject in all fields of engineering. Image filtering is one of the prime areas of image processing and its objective is to recover an image when it is corrupted with noise.

This research work focuses on the development of algorithms for the removal of impulse and Gaussian noises from digital color images in spatial domain. Various issues related to this problem are studied for color as well as monochrome images and suitable filtering methods are suggested.

Digital images are often corrupted by noise during their acquisition and transmission. A fundamental problem in image processing relates to effective suppression of noise while keeping entirely the desired image features such as edges, textures, and fine details. In particular, two common sources of noise are the so called additive Gaussian noise and impulse noise which are introduced during the acquisition and transmission processes, respectively.

The nature of noise removal problem depends on the type of the noise corrupting the image. The two most commonly occurring types of noise are: Additive noise (e.g. Gaussian and Impulse noise) and Multiplicative noise (e.g. Speckle noise). The focus of this work is on additive noise removal. Noisy images can be found in many of today’s imaging applications. TV images are corrupted due to atmospheric interference and imperfections in the image reception. Noise is also introduced in digital artworks when scanning damaged surfaces of the originals. Digital cameras may introduce noise because of CCD sensor malfunction, electronic...
interference or flaws in data transmission, etc. In the recent past, many methods have been proposed in the literature for the remove of either Gaussian or impulse noise. However, not all methods are able to deal with images which are simultaneously corrupted with a mixture of Gaussian and impulse noise. Most filters for Gaussian noise suppression are designed to take advantage of the zero-mean property of the noise and try to suppress it by locally averaging pixel channel values.

A geometric feature-based filtering technique, referred to as the Adaptive Statistical Quality based Filtering Technique (ASQFT), is presented in this thesis for removal of impulse noise in corrupted color images. In contrast with the traditional noise detection techniques where only 1-D statistical information is used for noise detection and estimation, a novel noise detection method is proposed based on geometric characteristics and features (i.e., the 2-D information) of the corrupted pixel or the pixel region, leading to effective and efficient noise detection and estimation outcomes. A progressive restoration mechanism is devised using multipass nonlinear operations which adapt themselves to the intensity and the types of the noise. Extensive experiments conducted using a wide range of test color images have shown that the ASQFT is superior to many of existing well-known benchmark techniques, in terms of standard image restoration performance criteria, including objective measurements, the visual image quality, and the computational complexity.

The objective of this thesis is the introduction of fuzzy based algorithms for removal of impulse and Gaussian noise in color images. Two fuzzy filters for the removal of both impulse and Gaussian noise in color images are proposed. The proposed filter is able to efficiently suppress Gaussian noise and impulse noise, as well as mixed Gaussian-impulse noise. A fuzzy filter consisting of two sub filters is proposed for cancelling out the impulse noise. The first sub filter detects the noisy
pixel along with the amount of noise in it by utilizing three fuzzy membership functions. The second sub filter makes use of the relation between different color components of a pixel to remove the residual noise in the color image.

In the literature, fuzzy based methods have been used to avoid the color artifacts. However, these methods are successful only when the noise free vectors are available in sufficient number within the filtering window. It is observed that even with 15% noise in each channel, sufficient number of noise free vectors cannot be found in most of the filtering windows for restoration of noisy pixel. As a result, a high value of normalized color difference (NCD) is reported in the filtered image signifying a poor restoration of colors. To alleviate this problem, a new filtering scheme is suggested in the present work where a reference vector is generated by using a fuzzy median filter on the filtering window in which all the noisy components are replaced by component wise filtering. This reference vector is then used by the proposed filtering scheme for restoration of noisy components so that intensity as well as color is restored by altering only the noisy components.

In order to assess the performance of various proposed methods, several standard color test images are used in the experiments which have distinct features. The efficacy of the various filtering systems is evaluated in terms of objective quality measures such as the mean absolute error (MAE), the peak-signal-to-noise ratio (PSNR) and the normalized color difference (NCD) for color images.