Integrated Filter for Image Enhancement and Restoration

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Abstract:
Various methods have been proposed for image enhancement and restoration. The main difficulty is how to enhance the structures uniformly while suppressing the noise without artifacts. In this paper, we tackle this problem in the gradient domain instead of the traditional intensity domain. By enhancing the gradient field, we can enhance the structure uniformly without over-shooting at the boundary. Because the gradient field is very sensitive to noise, we apply an orientation-isotropy adaptive filter to the gradient field, suppressing the gradients in the noise regions while enhancing along the object boundaries. We also present a method for estimating the brightness transfer function between the input images for photometric calibration of the short-exposed image with respect to the long-exposed image. As no global blur PSF is assumed, our method can deal with blur from both camera and object motions. We demonstrate the algorithm by a series of experiments and simulations.

Keywords: Image, filter, noise, signal.

I. Introduction

Image filtering processes are applied on images to remove the different types of noise that are either present in the image during capturing or introduced into the image during transmission. The salt & pepper (impulse) noise is the one type of noise which is occurred during transmission of the images or due to bit errors or dead pixels in the image contents. The images are blurred due to object movement or camera displacement when we capture the image. This proposed Paper deals with removing the impulse noise, additive white Gaussian noise and blurredness simultaneously from the images. To remove the mixed types of noises from the image, we are going to design a filter which can remove such types of noises.

The basic problem in image processing is the image enhancement and the restoration in the noisy environment. If we want to enhance the quality of images, we can use various filtering techniques which are available in image processing. There are various filters which can remove the noise from images and preserve image details and enhance the quality of image.[1]

This proposed paper focuses on how to remove the noise from the image by preserving the image details. This purpose can be fulfilled somehow by using wiener and median filters. Combination of these two filters (A MODIFIED FILTER) has been proposed to remove mixed type of noise during image processing from images. The performance parameters for proposed filters are Mean Square Error (MSE) and Peak Signal to Noise Ratio (PSNR) because we are going to use the property that The minimum of the MSE & maximum of the PSNR gives the best result.

A. Objective

Image enhancement and restoration in a noisy environment are fundamental problems in image processing. Various filtering techniques have been developed to suppress noise in order to improve the quality of images. Many filters for image processing are designed assuming a specific noise distribution.

For example, linear techniques are used to remove Gaussian noise, and order statistic techniques are used to remove impulsive noise. Hybrid filters have been developed to remove either Gaussian or impulsive noise. [15] There are filters available which can remove only single type of noise from the images, but there are not single filters available which can remove noise simultaneously from the images.

The main objective of this paper is to design such type of filter which can remove a large amount or mixed type of noise from images. Hybrid filter is the combination of wiener filter and the median filter. This filter removes salt & pepper noise, additive white Gaussian noise and blurring effect from the images.[13]

B. Proposed filter

The winner-update algorithm can also speed up the search for k nearest neighbors, neighbors within a specified distance threshold, and neighbors close to the nearest neighbor.

Image enhancement techniques deal with accentuation or sharpening of image features, such as contrast, boundaries, edges, etc. Image enhancement techniques both in spatial domain and frequency domain have been discussed in this dissertation. The primary differences between the enhancement and restoration techniques have been brought out here.

Some of the important techniques of image restoration like Wiener filter, restoration of impulse noise embedded image and blurred image have been discussed in this dissertation. In signal processing, it is often desirable to be able to perform some kind of noise reduction on an image or signal. The median filter is a nonlinear digital filtering technique, often used to remove noise. Such noise reduction is a typical pre-processing step to improve the results of later processing (for example, edge detection on an image). Median filtering is very widely used in digital image processing because, under certain conditions, it preserves edges while removing noise. The main idea of the median filter is to run through the signal entry by entry, replacing each entry with the median of neighboring
entries. The pattern of neighbors is called the "window", which slides, entry by entry, over the entire signal. For 1D signal, the most obvious window is just the first few preceding and following entries, whereas for 2D (or higher-dimensional) signals such as images, more complex window patterns are possible (such as "box" or "cross" patterns). Note that if the window has an odd number of entries, then the median is simple to define: it is just the middle value after all the entries in the window are sorted numerically. The median filter is normally used to reduce noise in an image, somewhat like the mean filter. However, it often does a better job than the mean filter of preserving useful detail in the image. Like the mean filter, the median filter considers each pixel in the image in turn and looks at its nearby neighbors to decide whether or not it is representative of its surroundings. Instead of simply replacing the pixel value with the mean of neighboring pixel values, it replaces it with the median of those values. The median is calculated by first sorting all the pixel values from the surrounding neighborhood into numerical order and then replacing the pixel being considered with the middle pixel value. By calculating the median value of a neighborhood rather than the mean filter, the median filter has two main advantages over the mean filter: The median is a more robust average than the mean and so a single very unrepresentative pixel in a neighborhood will not affect the median value significantly. Since the median value must actually be the value of one of the pixels in the neighborhood, the median filter does not create new unrealistic pixel values when the filter straddles an edge. For this reason the median filter is much better at preserving sharp edges than the mean filter. The most important technique for removal of blur in images due to linear motion or unfocussed optics is the Wiener filter. From a signal processing standpoint, blurring due to linear motion in a photograph is the result of poor sampling. Each pixel in a digital representation of the photograph should represent the intensity of a single stationary point in front of the camera. Unfortunately, if the shutter speed is too slow and the camera is in motion, a given pixel will be an amalgam of intensities from points along the line of the camera's motion. This is a two-dimensional analogy to

\[ G(u,v) = F(u,v) \cdot H(u,v) \]  

Where F is the Fourier transform of an "ideal" version of a given image, and H is the blurring function. In this case H is a sine function: if three pixels in a line contain information from the same point on an image, the digital image will seem to have been convolved with a three-point boxcar in the time domain. Ideally one could reverse-engineer a Fest, or F estimate, if G and H are known. This technique is inverse filtering. It should be noted that the image restoration tools described here work in a similar manner for cases with blur due to incorrect focus. In this case the only difference is in the selection of H. The 2-d Fourier transform of H for motion is a series of sine functions in parallel on a line perpendicular to the direction of motion; and the 2-d Fourier transform of H for focus blurring is the sombrero function, described elsewhere. In the real world, however, there are two problems with this method. First, H is not known precisely. Engineers can guess at the blurring function for a given circumstance, but determination of a good blurring function requires lots of trial and error. Second, inverse filtering fails in some circumstances because the sine function goes to 0 at some values of x and y. Real pictures contain noise which becomes amplified to the point of destroying all attempts at reconstruction of a Fest. The inverse filtering is a restoration technique for deconvolution, i.e., when the image is blurred by a known process filter, it is possible to recover the image by inverse filtering or generalized inverse filtering. However, inverse filtering is very sensitive to additive noise. The approach of reducing one degradation at a time allows us to develop a restoration algorithm for each type of degradation and simply combine them. The Wiener filtering executes an optimal tradeoff between inverse filtering and noise smoothing. It removes the additive noise and inverts the blurring simultaneously. The Wiener filtering is optimal in terms of the mean square error. In other words, it minimizes the overall mean square error in the process of inverse filtering and noise smoothing. The Wiener filtering is a linear estimation of the original image. The approach is based on a stochastic framework. Where are respectively power spectra of the original image and the additive noise, and the blurring filter? It is easy to see that the Wiener filter has two separate parts, an inverse filtering part and a noise smoothing part. It not only performs the deconvolution by inverse filtering (high pass filtering) but also removes the noise with a compression operation (low pass filtering) [17]. This paper deals with removing the impulse noise, additive white Gaussian noise and blurredness simultaneously from the images. To remove the mixed types of noises from the image, we design a modified filter which can remove such types of noises. The purposed filter is a combination of wiener filter and median filter. Combination or modified filters have been proposed to remove mixed type of noise during image processing from images. When both of these filters are combined (either in series or parallel), we get the desired result. The performance parameters are Mean Square Error (MSE) and Peak Signal to Noise Ratio (PSNR).

References


