A NOVEL APPROACH FOR IMAGE RESTORATION VIA NEAREST NEIGHBOUR METHOD

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ABSTRACT

In the past two decades, the technique of image processing has made its way into every aspect of today's tech-savvy society. Its applications encompass a wide variety of specialized disciplines including medical imaging, machine vision, remote sensing and astronomy. Personal images captured by various digital cameras can easily be manipulated by a variety of dedicated image processing algorithms .Image restoration can be described as an important part of image processing technique. Image restoration has proved to be an active field of research in the present days. The basic objective is to enhance the quality of an image by removing defects and make it look pleasing. In this chapter, we propose an image restoration algorithm in MATLAB which is based on the neighbourhood property of a pixel. We focus on a certain iterative process to carry out restoration. One such method described in this regard is the Nearest Neighbourhood Method.

Keywords: *Image restoration, image processing, good pixel, noisy pixel, image degradation.*

1. INTRODUCTION

Image processing algorithms are basically developed to overcome different problems. Some of these include image restoration, image enhancement, image segmentation and the list goes on. In this paper, a novel approach for image restoration has been explained. Images captured by various digital devices may be corrupted due to several reasons. To carry out any further processing on these images, restoration has to be done. Image restoration is the task of minimizing the degradation in an image i.e. recovering an image which has been degraded due to presence of noise and the original scene is not clear. Image restoration assures good insights of image when it is subjected to further techniques of image processing. Image restoration is a field of engineering that deals with the methods used to recover an ideal image from its degraded version. Due to certain imperfections in the imaging or capturing process, the captured image is a degraded version of the original scene. The imperfections in the images captured could be due to camera misfocus, motion blurs i.e. whenever there is a relative motion between camera and the scene being captured, the image captured is degraded, and the aerial photographs produced for remote sensing purposes have blurness introduced because of atmospheric turbulences. As a result, the undoing of these imperfections is crucial for many of the image processing tasks. The idea of restoration of such degraded images has become an important tool for many technological applications such as space imaging, medical imaging and many other post-processing techniques. There are many different approaches in solving this problem. However, the most universal approach is that of the statistical approach. In this approach, the statistical data associated with an image is made use of in undoing the effects of degradations. In the proposed paper, we use the mean filtering technique to compute mean of a particular neighbourhood window and then replace the central pixel by the mean value of its neighbours. The prime objective of the algorithm is that the restoration is confined to a particular window size and all the pixels in that window are used for restoration. The experimental results obtained show that the mean filtering algorithm brings about restoration of the given image to a good level. The NN Method (N=1) entails the use of distance transform to determine the N'th nearest good pixel to every good pixel. In the Nearest Neighbour Method for N=1, results were obtained for two different distance transforms, viz, City-block and Chessboard distance transforms. The grey-scale input image seemed to be restored to a good level for Chessboard

distances. The proposed algorithm was implemented on several standard test images and the results were observed.

The main objective of this paper is to introduce a novel method for image restoration, whose basic aim is to make an image noise-free. Image restoration happens to be one of the pre-processing tasks during many image processing techniques. Image restoration plays a pivotal role for tasks like Edge Detection, Image Segmentation etc. Hence, the undoing of all the degradations of an image is an indispensable part for obtaining better results in all the other image processing techniques.

The entire paper is organized in the following sequence. In section-1, the idea of restoration has been proposed. In section-2, the nearest neighbour method implemented has been elucidated along with the algorithm. In section-3, the result obtained for the implementation of algorithm in MATLAB has been presented. Finally, the paper concludes with references.

2. METHOD OF RESTORATION

Digital images are corrupted by various kinds of noise during the process of acquisition and/or transmission. The detection and removal of this noise plays a crucial role in restoration. Estimating the noise level from a single image seems like an impossible task, and due to this we need to recognize whether local image variations are dude to color, texture, or lighting variations from the image itself or due to the noise. It might seem that accurate estimation of the noise level would require a very sophisticated prior model for images. However, in this piece of work, we use the mean filter to compute the mean of all the neighbours and further replace the centre pixel by the mean value. This ensures restoration of a noisy image to a very good extent.

Image restoration is usually the first step of the whole image processing process. It increases the quality of the image by getting rid of noisy pixels. The restoration of an actually degraded image can be done by writing algorithms, which go on for identifying a noisy pixel in the entire image. The image restoration technique appears in many fields. These include- astronomy, military, medicines to name a few. Photo processing labs may also find restoration techniques a valuable tool in touching up special photographs. These fields have diverse aims for image restoration, but certain fundamentals are common to all image restoration problems.

The degradations may have many causes, but the two types of degradations that are often dominant are noise and blurring, each of which introduces peculiar problems in image restoration. In the algorithm mentioned, the degradation introduced due to blurring is nullified. This blurring can be caused due to relative motion between the camera and the original scene, or by an optical system that generates out of focus images. When aerial photographs are produced for remote sensing purposes, blurs are introduced in the images due to atmospheric turbulences, aberrations in the optical systems and relative motion between the camera and the ground. Hence, with all these possibilities, we need to carry out restoration of images produced by the devices. Also, when all this happens, some amount of information contained in the original scene is lost or hidden due to blurring of image. Image processing method should deal with the basic fact that information has been lost or obscured. The main obstruction in restoration technique could be the lack of knowledge about degradations. In most of the cases, the degradation actually destroys the information in an image, and the knowledge of degradation can be insufficient to counteract the degradation. On the other hand, most restoration algorithms require some amount of prior information in order to get a restored image. This information can be provided in many ways. The best source of information can be obtained by making an assumption that the original scene is smooth i.e. there is a degree of correlation between the various neighbouring points in an image or say, all the pixels in an image are somehow related to each other. Therefore, we compute the mean value in a filtering window and replace the corrupted pixel by mean of its neighbours. This holds true for every real-life image, but, the degree and the type of correlation may vary significantly from one image to other.

2.1 Image Restoration Technique by Nearest Neighbour Method with N=1

As the name says, to carry out restoration, we consider the nearest neighbours of a pixel. In this paper, we consider for N=1, i.e. a total of eight neighbours of each pixel are considered in a filtering window of 3x3.The size of the window can be more than 3x3 too. In the 2D grid of picture elements, each element has a certain correlation with its nearest elements. With the aid of this property, we can write algorithms to replace a noisy pixel by a value which happens to be the mean of all the nearest neighbours. This ensures a good level of restoration as shown in the results.

The algorithm proposed carries out an iterative process wherein the mean intensity is found and further replacement of noisy pixel is done. Consider an input image Im. Let us define a pixel at a position (i,j) in the input image. Firstly, the probability of occurrence of each neighbour of Im(i,j) is calculated. For a total of eight neighbours in that window, the mean value is obtained by using the following expression

$$M = \sum_{i=1}^{N} x_i \, p(x_i) \qquad (1)$$

The value obtained in the above case gives the mean of all neighbouring points of a particular pixel. This gives a value what we call as a ‘’good pixel value’’ .Hence we replace the central corrupt pixel by this good pixel value. This ensures the restoration of the given image by removing the corrupted pixels. The process is carried out for Chessboard distance and City-block distance transforms separately. In the chessboard distance transform, all the eight neighbours of a pixel are used in computing the mean value, whereas in city-block, only four neighbouring points are used. The result obtained for Chessboard distances is a better one as compared to the results of City-block distances. This can be seen in the further section of the paper.

To add to the problem faced in this method, there is a difficulty to test the restoration of edges in an image. Restoration of the edge pixels by using the above mentioned method is not possible. The whole image is composed of different image squares which are randomly arranged. The boundaries of different images should be regarded as edges and there is absolutely no relation between the pixels belonged to different image squares. However, when we restore the pixels on the boundaries, we count the contributions from pixels and consider all the nearest squares. This causes the blur of the boundaries and can extend to the whole image after iterations. To solve this boundary problem, we can either ignore the restoration of the pixels which form the boundaries of the image. The algorithm below works with this idea i.e. the boundary elements are left untouched or we can say that the boundary restoration does not take place, whereas only body restoration happens.

2.2 Algorithm

Step1. Read an image into MATLAB environment.

Step2. Display the image read.

Step3. Consider a pixel(say im(i,j)) and identify its nearest neighbours. Take all the eight neighbours for chessboard distance and four for city-block distance.

Step4. Extract a sub-matrix containing the elements of im(i,j).

Step5. Calculate the mean value of all the neighbours of the sub-matrix.

Step6. Approximate the mean value obtained in Step 5.

Step7. Replace the pixel at im(i,j) with the value obtained in Step 6. Go to Step 3.

Step8. Display the restored image.

3. RESULT

Fig 1. Input image

Fig 2. Output image

As seen in Fig-1, the input image is a noisy image. It has got some degree of noise density in it. The objective of the paper is to remove all the noise from the image and make it a good image. The proposed algorithm was tested on several standard test images and the above result was obtained for the image which is corrupted by noise. As mentioned earlier, the algorithm was carried out for City-block and Chessboard distance transforms to find out a good pixel value for a corrupt pixel. The result for City-block distance transform is not as good as that of Chessboard distance transform. As a result of this, the above result was obtained for chessboard distance transform i.e. for a given pixel at (i,j), all the eight neighbours of it are taken into account for restoring a pixel at (i,j). The output image is shown in Fig-2 and each corrupt pixel in it is replaced by the mean value of its neighbours. The observation of output image gives an idea that a noisy input image can be restored to a good level.

4. CONCLUSION

In this paper, we proposed a grey-level image restoration method which is based on the intensities of the nearest neighbours of a pixel. In particular, a method for N=1 which restores a given gray-level image has been proposed. The proposed restoration algorithm works on finding out the mean value of all the neighbours which come in a window (3X3), and thereby calculating the probability of occurrence of each pixel value. The simulation result obtained is a better one as the image seems to be restored to a good level. Different neighbourhood size in an image can either worsen or improve the restoration level and due to this, there exists a drawback of the algorithm. The drawback is that it cannot be applied to restore the elements which are at the boundaries. For this, we need to carry out certain edge detection techniques like Sobel Edge Detection Technique and Canny Edge Detection Technique.

As future work, better results can be obtained for N>1 i.e. by increasing the size of the filtering window, using artificial intelligence techniques like fuzzy logic and artificial neural networks. Already, a lot of classical filters have been designed for image noise reduction. However, the performances of all these filers are not satisfactory. To cope with the drawbacks of classical filters, several fuzzifications can be constructed. By writing fuzzy rules, we can implement the same to make the entire system an intelligent system whose performance would be better than the classical ones.

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