AN OVERVIEW OF IMAGE RESTORATION TECHNIQUES

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ABSTRACT
In the machine lead life of humans, Image processing comes handy for useful information extraction from images for machine and human interpretation. There are different types of image processing i.e., Visualization, Recognition, Sharpening, Restoration, Pattern Recognition and Retrieval. The contribution of this paper is an in-depth survey of widely used image restoration techniques. One of the most fundamental stages, Image restoration involves making specific adjustments to digital image in accordance with predetermined criteria. The primary purpose of restoration is to reconstruct a deteriorated image using some prior understanding of the phenomenon of image deterioration. The restoration process is objective in nature, its sole objective is removing blur in an image using deblurring function. Images can be restored using procedure that can be spatially defined. Probabilistic model of image degradations used as base for Image restoration. As a result, to increase the overall quality of the photographs image restoration is used.

Keywords: - *Image Processing, Image Restoration Techniques, NAS-RIF, Block Matching.*

1.0 INTRODUCTION

Image processing is an approach used to improve the data (raw data) detected by installed sensors on several components of life for various purposes. The result is higher standard since the components are more visible than in the raw felt images. Picture processing involves several essential phases, such as representation, image enhancement, image analysis, image reconstruction, image pre-processing, image data size minimization (compression) and image restoration.

Image Restoration: It's processing which removal or reduction of degradations that occur during image acquisition, like camera motion blur, pixel value errors, out of focus blur, or noise is done by employing prior knowledge of the deterioration's occurrence. Which means, Image restoration is concerned with deterioration modeling and application of the procedure in reverse to reconstruct the image. Image restoration offers an extensive range of applications.

Fig 1. Restoring degraded image due to external factors

Image restoration is used to restore or mend defects in images .

The picture restoration approaches are geared toward modeling degradations like blur, therefore requires the adoption of many filters to approximate the raw image.

The raw images are degraded by a degraded function let us suppose f(x,y) and channel transmission noise as n(x,y), yielding the degraded image g(x,y). The purpose of picture restoration is to obtain a target that is close to the raw input. The blurred image can be explained using the following equation:

$$g(x,y) = f(x,y)*f(x,y) + n(x,y)$$

2.0 RESTORATION TECHNIQUES

2.1 Median Filter

As the name implies it is a statistical method. The median of the pixels in the detected neighborhood replaces the value of pixels in this method. The purpose is to eliminate the salt and pepper noise. Median filter reduces the noise and also preserve the edges. This has the advantage over the smoothing model because it prevents the image from becoming blurry.

Fig 2. Median Filter Restoration Technique

2.2 Adaptive Filter

In this technique, behavioral differences are dependent on statistical properties of the images within the filter region. It is a linear filter with a transfer function that is controlled by a variable parameter. In comparison to other filters, these filters use color and gray space to remove impulse noise from photos. It offers the best noise suppression performance, preserves edges significantly better, and consequently produces superior features.

2.3 Linear Filter

In this, every pixel is replaced with the linear combination of their neighbors. The processes which are carried out are sharpening, smoothing and edge improvement. That is why it is used in Gaussian noise as well as in salt and pepper noise.

2.4 IBD (Iterative Blind De-convolution) method

Ayers and Dainty invented this approach in 1988. It is, as the name implies, a blind de-convolution method. The IBD method computes the Fourier transform, which requires less processing power.

Image recovery can be achieved with little to no prior knowledge of PSF (Point Source Function). It produces better quality and resolution of image. This technique has the disadvantage of not ensuring convergence.

2.5 Non-Negative and Support Constraints Recursive Inverse Filtering (NAS-RIF)

Blind Deconvolution seeks to rebuild an accurate approximated image from a blurred image. D. Kundur proposed the NAS-RIF algorithm (Non-Negative and Support Constraints Recursive Inverse Filtering) to accomplish this goal. The NAS-RIF algorithm estimates the target picture based on the give image. The estimation is made by minimizing an error function that contains the domain of the image and non-negative information about the pixels in the image. There is a realistic solution that optimizes the error function globally. In theory, the estimation corresponds to the genuine image.

2.6 Super-resolution restoration algorithm based on gradient adaptive interpolation

The essential notion behind gradient-based adaptive interpolation is that the interpolated pixel value is modified By the local gradient of a pixel particularly at image edge areas. The smaller the local gradient of a pixel, the more influence it should have on the interpolated pixel. The process is divided into three steps: registration, fusion and deblurring. First, we estimate the motions of the low-resolution images using the frequency domain registration approach. According to the motion, low resolution images are mapped to a uniform high-resolution grid, and then a high-resolution image is formed using gradient-based adaptive interpolation. Finally, the Wiener filter is to lessen the effects of the system's blurring and noise. The primary benefit of this algorithm is very less computation Complexity.

2.7 Deconvolution Using a Sparse Prior

This algorithm constructs the Deconvolution problem as a determining the maximum a-poster estimate of the raw image given the observation. Furthermore, the approach makes use of a previously enforced spatial-domain sparseness of the picture derivatives. A repetitive re-weighted least square method is used to solve the concluding non-convex optimization problem. Although this technique was not designed specifically for Poisoning observations, it has been used effectively on raw photos. We can improve the results by adjusting the smoothness-weight parameter and allowing for a suitable range of iterations.

2.8 Block Matching

Because the presence of noise has a substantial impact on the accuracy of block matching, high correlation containing blocks are chosen. In the local 2D transform domain, a similarity measure on block of pixels is used to achieve a rough initial de-noising. After dividing the image in blocks blur is removed from each and every block in the same manner.

2.9 Deconvolution using Regularized Filter (DRF)

It refers to a method of Non-Blind Deconvolution. These techniques can be used effectively when smoothness-like restrictions are given to the recovered image and only a limited set of noise information is available. A regularized filter and limited least square restoration are used to repair the damaged image.

2.10 Lucy-Richardson Algorithm Technique

IR or Image Restoration is classified as blind or non-blind deconvolution. PSF is recognized in non-blind people. The Richardson-Lucy approach is the most widely used for improving the photoemission spectra obtained in modern hemispherical electron spectrometers and sharpening astronomical images. The reason for its growing importance is its capacity to generate high quality reconstructed images in the midst of high noise levels. Leon Lucy and William Richardson discovered it in the early 1970 using Baye's Theorem. Lucy Richardson's method is a nonlinear iterative one. Because it produces better outcomes than linear techniques, this strategy is gaining popularity. The PSF is the frequency domain inverse Fourier transform of the Optical Transfer Function (OTF), where OTF provides a linear, position-invariant system response to an impulse. OTF is the Fourier transfer of the point (PSF).

3.0 APPLICATIONS OF RESTORATION

1. Multispectral image restoration can be performed over the multispectral bands of satellite imagery to optimize the resolution of the collected satellite images.
2. It can also be used to improve the resolution of still photographs captured by mobile cameras.
3. The Gaussian and Poisson nodes have played a vital role in image restoration in astronomical applications.
4. Because resolution quality is limited in medical imaging applications such as computed tomography (CT) and magnetic resonance imaging (MRI), the SR technique is also effective. This allows surgeons to operate more safely and precisely on a specific portion of the body.
5. To increase the video resolution, motion blur prediction can be performed in live video processing software.

Table 1- Work done by Various Researchers

Sr. no	Technique Name	Author's Name	Publication month and Year	Discussion
1.	**Median Filter**	Sebastian A. Villar Sebastian Torcida Gerardo Acosta AnwarShah Javed IqbalBangash AbdulWaheedKhan[c]	May 2017	We can also do the whole image's pixels upgrade.
2.	**Adaptive Filter**	Rubeena NagasirishaBhattiprolu Shuqian Luo Jing Han	Oct 2001	In this technique, we can also use colors to edit and for increasing picture quality.
3.	**Linear Filter**	Eduardo A.B. da Silva, Gelson V. Mendonça, in The Electrical Engineering Handbook, 2005 FATIHAH MOHD PADZIL PROJECT SUPERVISOR: DR. GREGORY CREBBIN	2002, 2005	When performing linear filtering, the input is convolved with the filter function to produce the filtered image.
4.	**IBD**	Y.-P. Zhu T.-Z. Shen Y. Bai Xuan Mo, Jun Jiao Chen Shen	March 2020, 2010	In this, we can work on disadvantage of ensuring convergence.
5.	**NAS-RIF**	Raid A.M Wael Mohamed Khedr Mohamed A El-dosuky Mona Aoud C A Ong, J A Chambers	April 2014, Dec 1999	A unique no negativity and support constants recursive inverse (NAS-RIF) approach is suggested to recover the damaged image in order to obtain the genuine image.
6.	**Super-resolution restoration on algorithm based on gradient adaptive interpolation**	Jinyu Chu Ju Liu Jianping Qiao Xiaoling Wang JingZhang MinhaoShao LuluYu YunsongLi	Dec 2015, June 2020	The interpolation coefficients in this method take into account the local gradient of the original image in addition as the distance between the interpolated pixel and the next-door valid pixel.

7.	**Deconvolution Using a Sparse prior**	Hyung-Min Park Jong-Hwan Lee Soo-Young Lee Haoyuan Yang Xiuqin Su Songmao Chen	March 2019, April 2020	Image deconvolution is a challenging ill-posed problem when only partial information of the blur kernel is available.
8.	**Deconvolution Using a Regularized Filter**	Yayuan Feng Yu Shi Dianjun Sun Puneet Kaushik Mridul Chawla Gyanender Kumar	Feb 2016, Nov 2019	We can work on different filters for restoration of images.
9.	**Lucy-Richardson Algorithm Technique**	Suphongsa Khetkeeree. M. K. Khan S. Morigi L. Reichel F. Sgallari	March 2020, July 2010	This method, which is based on a modified Tikhonov regularization, consists of two sections for measuring the noise enhancement brought on by the deblurring procedure as well as the similarity of the images. The required deblurred image will be regulated by the regularization parameter.
10.	**Block Matching**	Sp Immanuel Dr. G. Josemin Bala Alma George • M. Sushma Sri	Jan 2011, May 2018	In this we can enhanced the picture quality of image.

4.0 CONCLUSION

Image restoration is a difficult topic to solve. The primary goal of this paper is to conduct a comparison investigation. Though each strategy has its own way of dealing with the situation and has its own set of advantages and disadvantages.

According to the preceding explanations, the employment of the approaches is determined by the comprehension, need, and quality of the output required. Before employing any filtering approach, it is vital to gain a deeper understanding, which necessitates extensive research, although other studies have unequivocally claimed that Lucy-Richardson and Wiener are likely to offer the greatest results.

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