

Design and Implementation of Super Resolution Reconstruction Based On Efficient Restoration Techniques

^[1] Kamalavva Totagi ^[2] Chidananda Murthy M V ^[3] M Z Kurian

^{[1][2][3]} Department of Electronics and Communication,

Sri Siddhartha Institute of Technology, Tumkur, Karnataka, India.

^[1] kamalatotagi33@gmail.com, ^[2] chidussit@yahoo.com, ^[3] mzkurianvc@yahoo.com

Abstract— Super Resolution (SR) image can be obtained from a set of Low Resolution (LR) images with noise and blur. The main object of Super Resolution is to get high resolution, high quality image from Low Resolution images. To remove the blur and noises caused by the imaging system as well as recover information, restoration techniques are used. Super resolution imaging processes one or more low resolution images acquired from the same scene to produce a single higher resolution image with more information. Recently, it has been one of the most active research areas to get high-resolution image from a low-resolution image, and for the communication purpose it is necessary to compress the information.

To achieve SR, it should be restored properly and free from artifacts such as noises, blur and aliasing. In this paper, the various restoration techniques are designed and implemented. It significantly improves the quality and resolution of image. Restoration recovers the original image by degradation.

Keywords: Super resolution, Restoration, Noises, Blur and Filtering.

I. INTRODUCTION

Capturing high quality images is very critical process; the quality of image information determines efficiency and effectiveness of various applications such as medical imaging, remote sensing, surveillance, astronomy and video conferencing etc. To improve the efficiency of the system high quality images should be required. Efficiency increases by different methods using high quality sensors i.e. by using high resolution imaging system, high resolution image can be obtained but it is more costly and bulky. To avoid such problem and low resolution image system still can be used using Super resolution technique. In contrast, the computational imaging system is one, which combines the power of digital processing with data gathered from optical elements to generate HR images. Artifacts such as disturbance, aliasing, blurring, and noise may be affect the spatial resolution of an imaging system.

The basic problem is to obtain an HR image from multiple LR images. The basic assumption for increasing the spatial resolution in SR techniques is the availability of multiple LR images captured from the same scene. In SR, the LR images represent different “looks” at the same scene. In that LR images are sub-sampled as well as shifted with sub-

pixel precision. If the LR images are shifted by integer units, then each image contains the same information, and thus there is no new information that can be used to reconstruct an HR image. If the LR images have different sub-pixel shifts from each other and if noise, aliasing is present, and then ach image cannot be obtained from the others. Any movement in the camera or scene it will create blur and noises hence not get proper image which is necessary to other application. To overcome this will go for different restoration techniques.

Image restoration is objective process which recover image that has been degraded using model of degradation. The goal of restoration is to obtain an image as similar as possible to original image by the knowledge of degradation model. In the restoration techniques first degradation model will be done and an applying inverse process to recover the original image which is free from artifacts. There are different types of noises are present like salt and pepper noise, Gaussian noise Poisson noise etc and different blur called motion blur and so on. To restore the original image from the artifacts it uses different types of filtering. This paper introduces the various filtering like unsharp filter, regularized filter, Weiner filter and blind deconvolution to recover original image from artifacts. Because of this major advantage LR imaging systems can be still utilized with less cost.

The purpose of image restoration is to “compensate for” or “undo” defects, which degrade an image. Degradation comes in many forms such as motion blur, noise and camera mis-focus. In case like motion blur, it is possible to come-up with a very good estimate of the actual blurring function and “undo” the blur to restore the original image. In this project, will introduce and implement several of the methods used in the image processing world to restore images. The need of efficient image restoration techniques has grown with the massive production of digital image from various fields often taken in noisy condition. No matter how good image sensors are, an image restoration is always desirable to extend their various types of transmission data. So it is still exigent problem for researchers. The two main limitations in image accuracy are categorized as blur and noise. The SR image reconstruction is proved to be useful in many practical cases where multiple frames of the same scene can be obtained, including medical imaging, satellite imaging, and video applications.

II. RELATED WORKS

Esmaeil Famarazi, Dinesh Rajan and Marc P. Christensen .have proposed a unified blind method for multi-image super-resolution (MISR or SR), single-image blur deconvolution (SIBD), and multi-image blur deconvolution (MIBD) of low-resolution (LR) images degraded by linear space-invariant (LSI) blur, aliasing, and additive white Gaussian noise (AWGN). The proposed approach is based on alternating minimization (AM) of a new cost function with respect to the unknown high-resolution (HR) image and blurs, which improves the quality of blur. Blur deconvolution (BD) and super-resolution (SR) are two groups of techniques to increase the apparent resolution of the imaging system and recover the original image by various artifacts such as noise blur and aliasing[1].

A. Geetha Devi, T. Madhu and K. Lal Kishore have proposed the various fusion algorithms such as averaging method, Principle component analysis (PCA) and wavelet based Fusion, scale Invariant-wavelet Transform, Laplacian pyramid, Filter Subtract decimate(FSD)pyramid. This paper also proposes the blind deconvolution method to reduce the noise. This paper includes the maximum likelihood algorithm and obtaining PSF which is explicitly prior to the image restoration process. The method which is introduced is used when PSF is not known[2].

S.K. Satpathy, S.K. Nayak, K.K Nagwanshi, S. Panda, C. Ardil have presented an adaptive model for restoration Bayesian approach. The proposed method which is makes use of an prior noise model has been evaluated on

different types of images. Bayesian based algorithms and techniques of image processing have been described[3].

A. Shakul Hamid, S.P. Victor proposes Image Restoration model in Image processing and provides the analytical way of implementation towards real-time data with different level of implications. Their experimental setup initially focuses with images with blurring and noises. This paper perform a detailed study of inverse filter schema towards variant effect of noisy blurred images in the field of image processing which can be carried out with expected optimal output strategies. This paper introduces image restoration techniques with real time implementation of object representation and also perform algorithmic procedural strategies for the successful implementation of proposed research technique in several sampling domains with a maximum level of improvements[4],[5].

Min-Chun Yang and Yu-Chiang Frank Wang have proposed Learning-based approaches for image super-resolution (SR). In this paper, they present a novel self-learning approach for SR and advance support vector regression (SVR) with image sparse representation, which offers excellent generalization in modeling the relationship between images and their associated SR versions [6].

Michael Angelo Kandavalli and Raghava have presented main classes of methods to estimate the pixel values in HR grids, and interpolation-based approaches. In this paper, they are introduces interpolation-based approaches since both interpolation and filtering can be expressed in the form of a weighted sum. Frequency-domain approaches make explicit use of the aliasing relation between continuous Fourier transform and discrete Fourier transform [8].

Bahadir K. Gunturk and Murat Gevrekci have proposed a Bayesian super-resolution algorithm based on an imaging model that includes camera response function, exposure time, sensor noise, and quantization error in addition to spatial blurring and sampling [9].

Niyanta Panchal, Bhailal Limbasiya, Ankit Prajapati have proposed review of different image registration methods and compare all the methods. Then next using various Super resolution methods which is generate high-resolution(HR) image from one or more low resolution images and lastly different image quality metrics reviewed as measure the original image and reconstructed image[10].

III. PROPOSED METHODOLOGY

The diagram of the proposed system shows in fig: 3.1 gives the degradation/restoration process model.

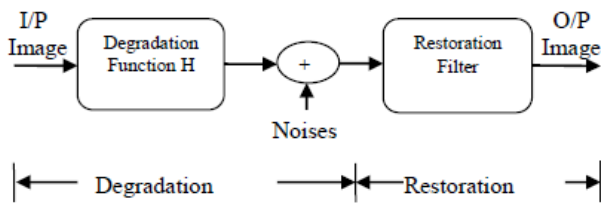


Fig 3.1: Degradation/Restoration process model.

A degradation function and additive noise that operate on an input image $f(x, y)$ to produce a degraded image:

$$g(x, y) = H[f(x, y)] + \eta(x, y)$$

Restoration model gives the and some knowledge about the degradation function and noise, obtain an estimate of the original image. The goal of the image restoration is obtaining an image as similar as possible to the original image. Only from the degraded image and knowledge of the degradation model. Image restoration is a well defined problem unlike image enhancement. Different restoration technique has been employed for the reduction of noise, blur restore the images with high resolution. Several Super Resolution reconstruction algorithms are implemented. This technique can be efficiently implemented in critical applications like a medical imaging, facial recognition, biometrics and remote sensing to extract the finer details of the image. The detailed description of the each module is explained below:

3.1 Noise Module:

A noise is introduced in the transmission medium due to a noisy channel, errors during the measurement process and during quantization of the data for digital storage. Each element in the imaging chain such as lenses, film, digitizer, etc. contributes to the degradation. Therefore, Noise is any undesired information that contaminates an image. Hence, the received image needs processing before it can be used in applications. A different noise model includes additive, multiplicative and impulse types of noise. They include Gaussian noise, salt and pepper noise, speckle noise and Poisson noise. A quantitative measure of comparison is provided by the peak signal to noise ratio of the image.

Typically images are corrupted with noise modeled with either a Gaussian or salt and pepper distribution. Another typical noise is a speckle noise, which is

multiplicative in nature. Noise is present in an image either in an additive or multiplicative form.

3.2. Blur Module:

Image may be corrupted by degradation such as linear frequency distortion, noise and blocking artifacts. The degradation consists of two distinct processes- the deterministic blur and the random noise. Blur is unsharp area caused by camera or object movement, inaccurate focusing, or the use of an aperture that gives shallow depth of field. Blurring in image arises from a variety of sources, like atmospheric scatter, lens defocus, optical aberration, spatial and sensor integration. Human visual systems are good at perceiving it. The degree of spreading(blurring) of the point object is a measure for the quality of an image system. One can use conventional image quality metrics like Mean Square Error(MSE), Peak-Signal to-Noise Ratio(PSNR) to perceive blur, but they are by definition reference based, which means that the system needs to have an idea of what an un-blurred image is. Blur is a form of bandwidth reduction of an ideal image owing to the imperfect image-formation process. It can be caused by relative motion between the camera and the scene or by an optical system that is out of focus. Image blurs can be of many types such as average, Gaussian, laplacian, motion etc., but there are only two common types of blur effects in digital image. There are Gaussian and motion types of blurs.

3.3 Restoration Techniques:

Image restoration is used to improve the appearance of an image by application of a restoration process that uses a mathematical model to remove image degradation. Examples of the types of degradation include blurring caused by motion of atmospheric disturbance, geometric distortion caused by imperfect lenses, superimposed interference patterns caused by mechanical systems, noise from electronic sources, for example in the case of acquiring images with a CCD (Charge Coupling Device) camera, light levels and sensor temperature are major factors affecting the amount of noise in the resulting image.

3.4. Regularized Filter:

Regularized de-convolution can be used effectively when constraints are applied on the recovered image and limited information is known about the additive noise. The blurred and noisy image is restored by a constrained least square restoration algorithm that uses a regularized filter. It uses the deconvreg function to de-blur an image using a regularized filter. A regularized filter can be used effectively when limited information is known about the additive noise.

Blind Deconvolution:

The blind deconvolution algorithm can be used effectively when no information about the distortion (blurring and noise) is known. Blind deconvolution is a deconvolution technique that permits recovery of the target scene from a single or set of "blurred" images in the presence of a poorly determined or unknown point spread function (PSF). Blind deconvolution can be performed iteratively, where by each iteration improves the estimation of the PSF and the scene. In this technique firstly, we have to make an estimate of the blurring operator i.e. PSF and then using that estimate we have to deblur the image. This method can be performed iteratively as well as non-iteratively. In iterative approach, each iteration improves the estimation of the PSF and by using that estimated PSF we can improve the resultant image repeatedly by bringing it closer to the original image.

The blind deconvolution is expressed as,

$$g(x, y) = f(x, y) * h(x, y)$$

$$g(x, y) = \sum_{(n,m)} f(n, m) h(x-n, y-m)$$

Where, '*' denotes the two dimensional linear convolution operator, $g(x, y)$ = Degraded image, $f(x, y)$ = Original image, $h(x, y)$ = Point spread function.

3.5 Wiener Filter:

The Wiener filtering executes an optimal tradeoff between inverse filtering and noise smoothing. It removes the additive noise and inverts the blurring simultaneously. So the Wiener filtering is optimal in terms of the mean square error because it minimizes the overall mean square error in the process inverse filtering and noise smoothing. Although the Wiener filtering is the optimal tradeoff of inverse filtering and noise smoothing, in the case when the blurring filter is singular, the Wiener filtering actually amplify the noise. This suggests that a denoising step is needed to remove the amplified noise. Image denoising techniques are necessary to remove the random additive noises while retaining as much as possible the important signal features.

Wiener filter's working principle is based on the least squares restoration problem. It is a method of restoring image in the presence of blur and noise. 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.

The frequency-domain expression for the Wiener filter is,

$$G(k, l) = \frac{H^*(k, l)}{|H(k, l)|^2 + S_u(k, l) / S_x(k, l)}$$

$H(k, l)$ = Point Spread Function, $S_u(k, l)$ = Noise Power Spectrum, $S_x(k, l)$ = Signal Power Spectrum.

IV. SYSTEM IMPLEMENTATION

The proposed system is implemented in GUI with the help of guide which is shown in fig 4.1. The detailed description is explained below:

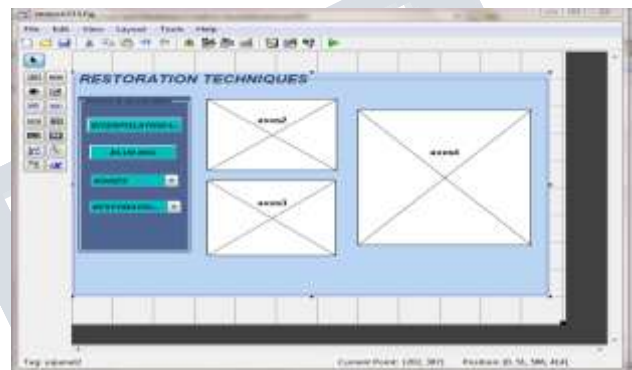


Fig 4.1: GUI guide for proposed system.

Here the image is selected either from library and then one of the various noises is added with the slider value to get the noisy image. The system also consists of popup menus to select restoration algorithms.

V.RESULTS

The experimental results for restoration with noises and blur are shown below. Fig.5.1 shows original image with gray scale. Fig.5.2 shows the Gaussian blur added to original image, Fig5.3, Fig5.4 and Fig5.5 shows the different noises applied to the image, like Poisson, Gaussian noise, salt & peppers.

Case I: Noises and Blur:



Fig 5.1: Input gray image.

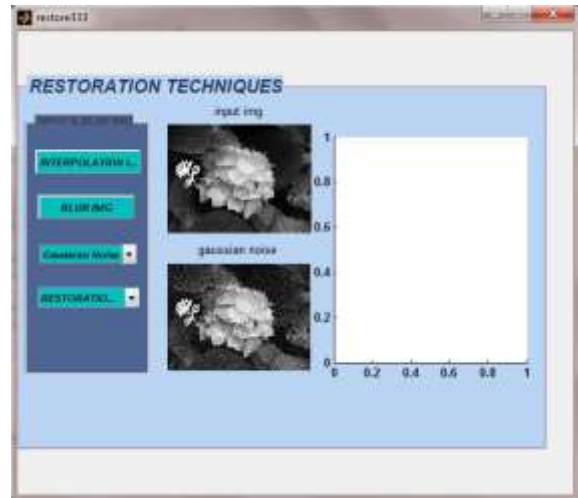


Fig 5.4: Adding Gaussian noise.

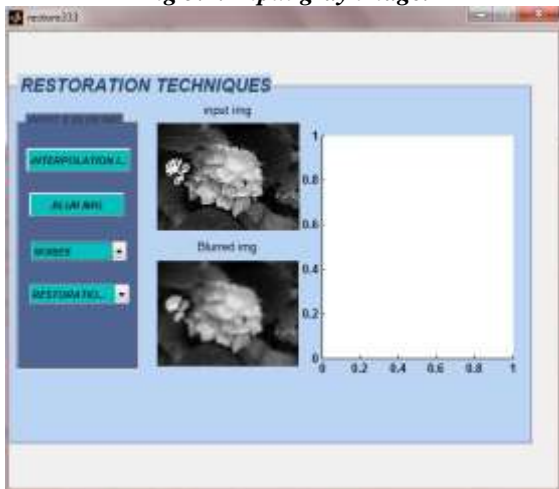


Fig 5.2: Adding Gaussian Blur.

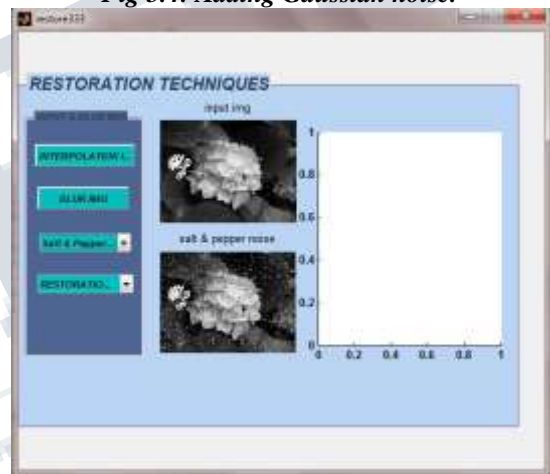


Fig 5.5: Adding salt and pepper noise.

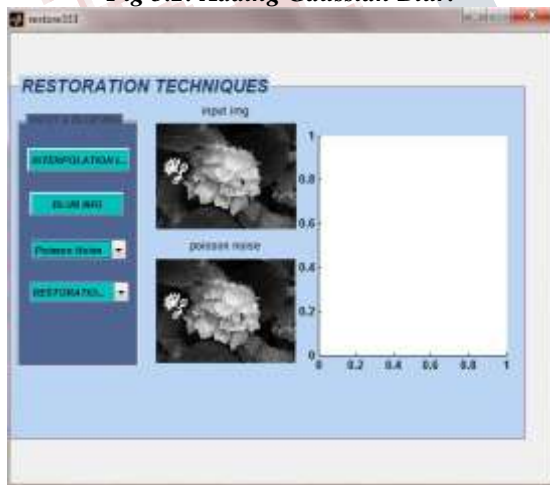


Fig 5.3: Adding Poisson noise.

Case II: Restoration Techniques:

Different restoration techniques like Blind Deconvolution, Regularized filter and Wiener filter are shown in Fig5.6, Fig5.7 and Fig5.8.

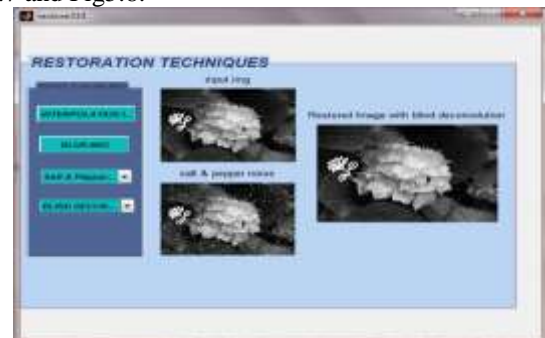


Fig 5.6: Restored image with Blind Deconvolution Technique.

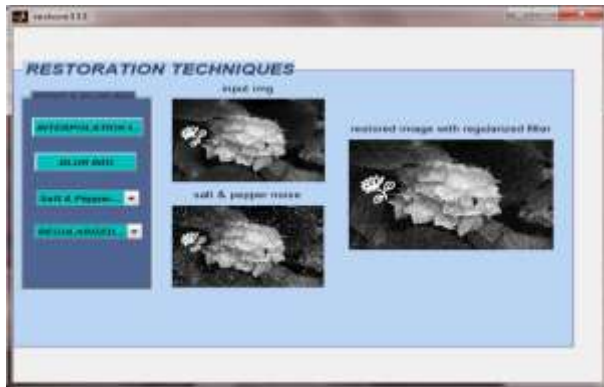


Fig 5.7: Restored image with Regularized Filter.

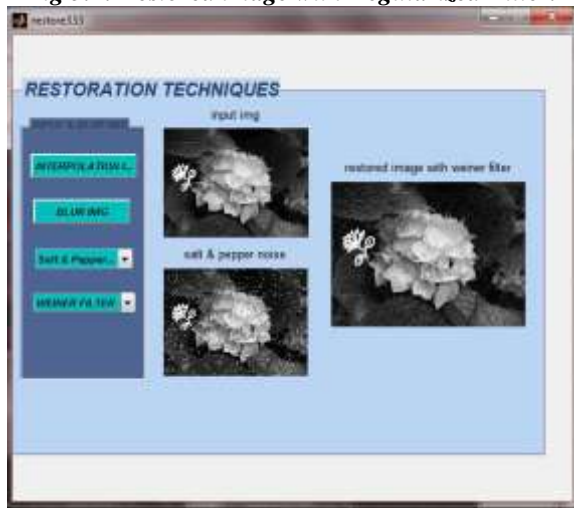


Fig 5.8: Restored image with Weiner Filter.

VI. CONCLUSION

In this paper, the different restoration techniques are designed and implemented which can be used to remove the artifact such as different noises and blur. This is a used to recover the original image from degraded image. In future work, an efficient and advanced restoration technique will design and implemented to get super resolution image.

REFERENCES

[1] Esmail Faramarzi, Member, IEEE, Dinesh Rajan, Senior Member, IEEE, and Marc P. Christensen, Senior Member, IEEE, "Unified Blind Method for Multi-Image Super-Resolution and Single/Multi-Image Blur Deconvolution", IEEE Transactions on Image Processing, VOL. 22, NO. 6, JUNE 2013

[2] A. Geetha Devi, T. Madhu and K. Lal Kishore, "An Improved Super Resolution Image Reconstruction using SVD

based Fusion and Blind Deconvolution techniques", International Journal of Signal Processing, Image Processing and Pattern Recognition ol.7, No.1 (2014), pp.283-298

[3] S.K. Satpathy, S.K. Nayak, K.K Nagwanshi, S. Panda, C. Ardil, "An Adaptive Model for Blind Image Restoration using Bayesian Approach", International Journal of Computer, EEC Engg V01:4, No:1,2010.

[4] A. Shakul Hamid, S.P. Victor, "Experimental Implementation of Image Restoration Schema using Inverse Filter Processing Techniques", International Journal of Engg and Computer Science ISSN:2319-7242.Vol 4 Issue April 2015, Page no. 11219-11223.

[5] B Chopade and P M Patil, "Single and Multi Frame Image Super-Resolution and its Performance Analysis: A Comprehensive Survey", International Journal of Computer Applications (0975 – 8887) Volume 111 – No 15, February 2015.

[6] Pandya Hardeep, Prof. Prashant B. Swadas, Prof. Mahasweta Joshi, "A Survey on Techniques and Challenges in Image Super Resolution Reconstruction", International Journal of Computer Science and Mobile Computing ISSN 2320-088X IJCSMC, Vol. 2, Issue. 4, April 2013, pg.317 – 325.

[7] Min-Chun Yang and Yu-Chiang Frank Wang, Member, IEEE, "A Self-Learning Approach to Single Image Super-Resolution ", IEEE transactions on multimedia, vol. 15, no. 3, april 2013.

[8] Simon Baker and Takeo Kanade, "Limits on Super-Resolution and How to Break Them", to Appear in the IEEE Transactions on Pattern Analysis and Machine Intelligence, The Robotics Institute Carnegie Mellon University Pittsburgh, PA 15213