A Survey on Image Deblurring Techniques Which Uses Blind Image Deconvolution.

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Abstract: Images taken with the cameras consist of different level of noise and different types of blur. This happens because of the shaking movement of cameras or objects which are captured, atmospheric events, out of focus, low quality of captured devices, etc. Now a day images are used is so many sensitive fields like medical, remote sensing, artificial intelligence, and security. So, images need to be accurate to gain proper application of that image. So, this study focuses on different image deblurring techniques which uses blind deconvolution techniques. Here we also compare these techniques in term of method used, advantages and limitation. And based on that we suggested a solution to overcome the limitation in existing technique up to certain extant. In our proposed method we first segment image into different object region and then apply image deblurring technique with class-based priors on each object separately according to their class. After this we combine all region so that we can get our deblurred image.

IndexTerms **- Image Restoration, Blind Deconvolution, Class based priors, Point Spread Function, Image deblurring.**

I. INTRODUCTION

Now a days, image processing is among rapidly growing technologies today, with its applications in various fields and it is used to solve wide variety of problems. Also, in future there is more artificial intelligence-based machines control the system based on the vision and we can say images, so the quality of image is more important. Images are sometime degraded by various reasons like motion of object to be captured, atmospheric events, losing focus in camera, Shaking movement of hand, etc. So, before using this degraded or blurred images we need to perform some operation for removing this blur factor.

Image deblurring is the process of improvement of an image using objective criteria and prior knowledge of blurring factor and techniques to make it look as an original image [9]. Image Restoration techniques are first modeled using degradation and then original image is recovered using inverse process. Image restoration techniques exist in both spatial and frequency domain.

Image Degradation and Restoration Model [8]

Image can be represented as a combination of small blocks called pixel. An image can be defined as a two-dimensional function *I*

$$I = f(x, y) \qquad (1)$$

Where, x and y are spatial coordinates. (x,y) represents a pixel. I is the intensity or grey level value which is the amplitude of *f* at any point (x,y). If the values of the coordinates (spatial coordinates) and the amplitude are finite and discrete, then it is called digital image. The degraded image g(x,y) can be represented as

$$g(x, y) = h(x, y) * f(x, y) + \eta(x, y) \qquad (2)$$

Where h(x,y) is the degradation function also known as point spread function, f(x,y) is the original image, the symbol * indicates convolution and η(x,y) is the additive noise.

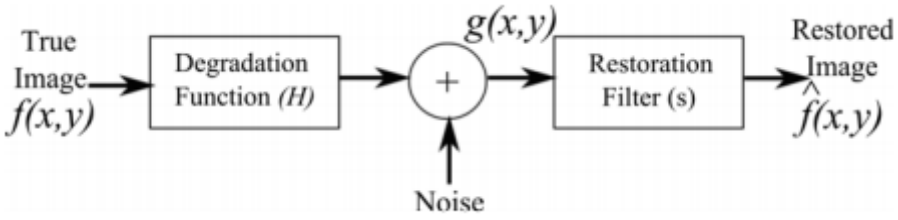

Figure 1 Image Degradation and Restoration Model [12]

Convolution in spatial domain is analogous to multiplication in frequency domain. So, we can write the model in frequency domain representation as

$$G(u, v) = H(u, v)F(u, v) + N(u, v) \qquad (3)$$

Where, terms in capital letters are Fourier transformation of corresponding terms in equation (2).

Image deblurring Techniques

Image deblurring Techniques can be divided in two types based on the knowledge of point spread function, H(u,v). Non-blind image deconvolution and Blind image deconvolution. In non-blind image deblurring we have known point spread function and blur image. Blind deconvolution techniques are used when we do not have prior knowledge of PSF causing blur and process used for degradation. [9,13]

In Blind deconvolution is more useful in real life situation because in most of the practical cases, knowing the PSF is not possible. For example, in applications like remote sensing and astronomy, if is difficult to estimate the scene which is we never seen before.

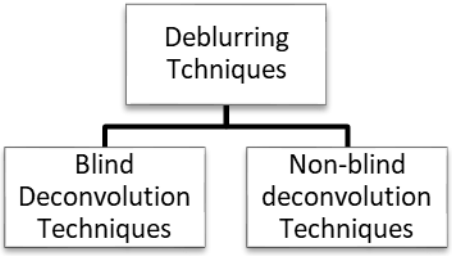

Figure 2 Classification of Restoration Techniques [10]

Image Segmentation

Segmentation is a process that divides an image into small parts or objects based on different characteristics. [7] In general, independent image segmentation is very tough tasks in image processing. Image segmentation is useful in many applications to identify specific objects or any specific characteristic of objects. It can identify the area of interest in an image. Segmentation can be carried out by two approach. [15]

Discontinuity detection-based approach

In this approach segment created based on the discontinuity of region. It is used edge detection techniques to create segments of image.

Similarity detection-based approach

In this approach image is segmented based on similarity in region of image. Example of this techniques are: thresholding techniques, region splitting and merging, region growing techniques. These techniques divide the image into regions which has similar set of pixels.

II. LITERATURE SURVEY

A. Deblurring using Class-Specific Prior.

In this paper, Author [1] use frequency domain for Image analysis due to the convenience in transformation of blur model between spatial and transfer domain. They first apply Butterworth bandpass filter on an image to avoid interference of signals. They use the class specific data as an image prior to get better result. In this algorithm verity of frequency components are selected from training image to compose the latent image. The latent image is constructed from the combination of bandpass components of the training images. So, this technique gives high accuracy regarding image and also able to deal with blurred images lacking high frequency detail. Even though this algorithm has a limitation is that it is only able to deblur images which contains only single objects but practically it is a week assumption.

B. Deblurring using class-adapted image priors

In this paper, Author [2] use patch-based image prior which are learn from a set of clean images belongs to a specific class. They use weaker prior on the blur so they can recover variety of filters. They use gaussian mixture model (GMM) based denoiser. Proposed method also plugged into an ADMM optimization algorithm for estimation of both the image and the blurring filter. This algorithm has several benefits like it is able to handle text images at high noise level and it can be used for various blurring filters. This algorithm also suffers from a limitation of setting the regularization parameter and stopping criteria for the inner ADMM algorithms, as well as for the outer iterations.

C. Deblurring using elastic-net based rank priors

In this paper, Author [3] propose a novel image prior based on elastic net regularization of singular values computed from similar patches of an image. They extend algorithm to deal with non-uniform deblurring problem. There deblurring model is based on the conventional MAP framework. The proposed method does not require any complex filtering strategies to select salient edges. Once the blur kernel is determined, the latent image can be estimated by a number of non-blind deconvolution methods, they use the iterative reweighted least square (IRLS) method. [3] If an image contains rich textures and these rich textures are located in most regions in this case this method fails.

D. Deblurring algorithm for noisy images with just noticeable blur

In this paper, Author [4] describe the JNB phenomenon and briefly analyses its causes. An image gradient related constrained factor is introduced based on image the prior of image noise's low gradient distribution. To reduce the algorithms time cost Richardson-Lucy method is used. For large images they used image segmentation model suitable for space variant blur. This method needs more specific parameters need to be adjusted when dealing with different type of noise like impulse noise.

E. Image restoration based on Reaction–diffusion equation

In this paper, Author [5] proposed an algorithm based on reaction-diffusion equation theory for restoring images degraded with various blur PSF and different type of noise. First RDER model is created using restoration ability of the diffusion equation and image detail preservation ability of the reaction equation. This method gives better performance in terms of impulse noise and mixed noise.

F. Deblurring using logarithmic image prior

In this paper, Author [6] shows that a simple Maximum a Posteriori formulation is enough to achieve state of art result. Their analysis confirms experimentally that priors should not necessary model natural image statistics to correctly estimate the blur kernel. They use two approaches Primal-dual approach and majorization-minimization approach for minimizing formulation.

Table 1: Comparison Table on Different Techniques

Sr No.	Paper Title	Method Used	Advantages	Limitation
1	Image Deblurring with a Class-Specific Prior [1]	Blind Deconvolution technique. Linear subspace of bandpass filters as a class-specific image prior. Butterworth bandpass filter.	High accuracy achieved. Dealing with blurred images lacking high frequency detail	Uniform blur specification. Not Suitable for image containing multiple object.
2	Blind image deblurring using class-adapted image priors [2]	Image priors based on statistical properties of generic natural image. Gaussian mixture model (GMM). Alternating direction method of multiplier (ADMM).	Able to handle text images at high noise level. Can be used for various blurring filters.	setting of the regularization parameter and stopping criteria for the inner ADMM algorithms, as well as for the outer iterations.
3	Blind image deblurring using elastic-net based rank priors. [3]	Blind Deconvolution technique. Iterative reweighted least square (IRLS) method.	Does not require any complex filtering strategy to select salient edges. Deal with non-uniform image deblurring	If an image contains rich textures and these rich. textures are located in most regions it fails.
4	A robust deblurring algorithm for noisy images with just noticeable blur. [4]	Blind Deconvolution technique. Richardson-Lucy Method. Gradient Distribution	Better balance of denoising and deblurring. Achieve higher image resolution. Reduced algorithm time cost	More specific parameters need to be adjusted when dealing with different type of noise like impulse noise.
5	Reaction–diffusion equation-based image restoration. [5]	Blind Deconvolution technique. Reaction–diffusion equation.	Better performance in terms of impulse noise and mixed noise.	Computation time is high
6	A logarithmic Image prior for blind deconvolution. [6]	Blind deconvolution. Primal-dual approach. Majorization-minimization approach. Logarithmic approximation.	Algorithm has a simple form. Fast implementation in primal dual approach. High accuracy in majorization-minimization approach.	The result is too coarse in case of primal-dual to achieve a same accuracy of MM.

III. PROPOSED SYSTEM

For Image deblurring process there are many techniques are developed. They are blind or non-blind deblurring algorithm, but in a practical scenario blind deconvolution for image restoration is more useful because there is in most of the situation the degradation function and degradation process is not known. In blind image deconvolution different prior images are used for estimating the blur kernel and original image but from above literature study we can conclude that the priors related to particular class of image gives better result. [14]

From study of literature we identified problem that whenever we use class specific prior for image deblurring we assume that our image is belong to only one class means that image contains only single object. But in practical scenario we cannot say that every image has only one object, it is a week assumption. For example, in traffic monitoring system images have multiple vehicles, persons and also animals are there.

Flow chart of the proposed method is as describe below.

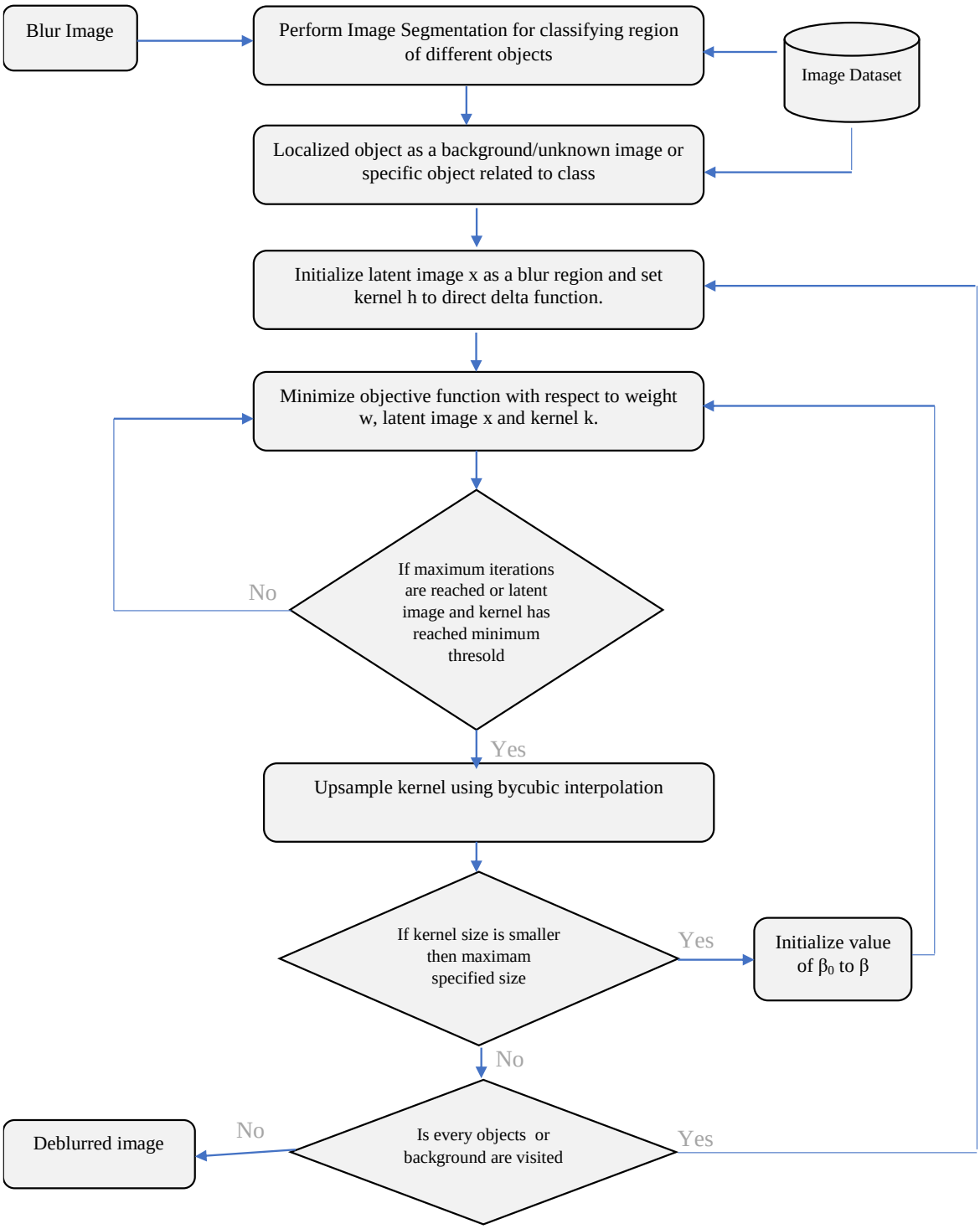

Figure 3 Flow chart of proposed system.

Steps of Proposed System

To overcome problem identified in the literature study we first use segmentation [11] for identifying different objects and use class information of particular object for extracting original image. And in last we combine all image parts to get full result. Here we made an assumption that blur is uniformly distributed. Steps of proposed system are as follow

Step1 Input blur image.
Step2 Perform image segmentation on image to differentiate objects in image and assign them particular class values
Step3 Initialize latent image as a blur object region and kernel as a direct delta function and take training set of particular object class images.
Step4 Minimize the objective function with respect to value of weight, latent image and kernel.
Step5 Perform step 4 until maximum iteration value exit or kernel and latent image reach the threshold value.
Step6 up sampled kernel using bicubic interpolation.
Step7 If kernel size is less then maximum size perform step 4 to step 6.

Step8 Until every object is deblurred with this process perform step 3 to step 7.
Step9 Combine segmented objects so we have an output deblurred image and kernel value.

IV. CONCLUSION

Here we studied about different techniques for blind image deconvolution, from that we conclude that the training images of same class have benefits over generic training images as a prior.so, in our proposed method we are using segmentation of images in different objects and based on that object we use training image data of same class to get the more accuracy of proposed method. So, we can improve accuracy of blind image deconvolution based on class-based priors.

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