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A REVIEW: IMPROVEMENT IN THE QUALITY OF SHAKY CAMERA IMAGES

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Abstract- Numerous modern technology applications make use of cameras. The basic principle of capturing an image in camera is the accumulation of photons in the given exposure time. For this purpose the basic requirement of camera and scene is to remain still. Camera shake is random phenomenon which causes due to hand vibrations and results in blurry image. In this paper, different methods are studied considering single image and multiple images under different conditions to remove the blur. These methods have some disadvantages, ringing occurs, gives slow response, fourier accumulation algorithm is proposed which overcome these disadvantages and gives latent image with better resolution.

Keywords: Camera shake, motion blur, single/multiple images, low light photography, image deblurring.

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INTRODUCTION

Taking photos in low-light environment is most challenging experiences in photography. When handheld camera is used for taking snaps, the resulting image may be blurred due to camera shake or movement of the object in the scene during the exposure period. According to capture strategy when image is captured using short exposure time, resultant image contains read noise and photon shot noise. On the other hand when image is captured using long exposure time then increase in handshake blur occurs and image gets blur. Motion blur is one of the reason of degradation of image. It is apparent streaking of rapidly moving objects in a still image or a sequence of images such as movie.

To remove this blur we use image restoration techniques, which focus on extracting the original image from the degraded one. Single image deblurring methods and multiple images deblurring methods are used to deal with the camera motion problem to get satisfying image. It is very transparent that multiple images contain lot of usable information than as single image.

Deconvolution is performed for image restoration in many applications such as astronomical speckle imaging, remote sensing and medical imaging. Removal of camera shake can be done with help of different methods, namely blind image restoration and non blind image restoration.

Blind image restoration is the process of estimating both the true image and the blur from the degraded image characteristics. The non-blind image restoration is the process of estimating the latent image with known blur kernel.

The section II gives literature review consist of different classical techniques to remove the blur based on different scenario. And the section III gives proposed method which is based on blind deconvolution. In which the least attenuated part is considered to build the latent image. Section IV gives the conclusion about the previous methods and proposed method.

I. Literature review

II.A. Single image blind deconvolution

Rob Fergus *et al* [1] proposed a method which assumes homogeneous blur over the image and negligible in plane rotational camera. This paper includes natural scenes and to find the blur kernel the Bayesian approach is used. The basic image convolution model is,

$$v = u * k + n \qquad (1)$$

Where v is blur image, u is latent sharp image k is unknown blur kernel and n denote sensor noise at each pixel. Our goal is to recover latent image u from blur image v without prior knowledge of kernel k.

The algorithm in this method has two main steps, firstly the input image is used to calculate the blur kernel and second, using the estimated kernel a standard deconvolution algorithm is applied to get the unblurred image. Four inputs are supplied from user to the algorithm: The blur image v, select one of the two initial estimates of blur kernel: it can be a horizontal line or a vertical line, a rectangular patch within the blur image and upper bound on the size of the blur kernel. Also, it requires input blur image v which is converted to a linear colour space before processing. In this experiment, inverse gamma correction is applied with gamma value equal to 2.2. In order to estimate the blur kernel, a multi-scale approach is used. For this a gray scale blurred patch P is formed by combining all the colour channels of original image within the user specified patch. A posterior distribution is applied using Bayes' rule.

$$p(K, \nabla Lp \mid \nabla P) \propto p(\nabla P \mid K, \nabla Lp)p(\nabla Lp)\, p(K)$$

Where p represents the prior value of kernel K and latent image L and ∇ represents the image gradients. After the estimation the kernel, the Latent image is reconstructed using Richardson-Lucy (RL) algorithm. Before applying RL, the noise in the kernel is removed by applying dynamic threshold depending on the maximum intensity value present in the kernel, which sets all the elements below a certain value to zero. The output RL is then corrected using gamma 2.2 and its intensity histogram is matched with blur input image v.

The advantage of the single image blind deconvolution image is that it is a linear tone scale method.

II. B. Multi-image blind deconvolution

Alex Rav-Acha *et al.* [5] showed that when the blur directions of two motion blurred images are different the quality of image restoration can be improved. In this paper one dimensional PSF (Point Spread Function) is used to form a blur function. It is assumed that the blur function is shift invariant and is known. The blurred function can be estimated from sequence of images instead of handling it frame by frame. The advantage of using multiple images is most important for blur functions which contains many zeroes in their frequency response such as uniform blur. When only a single image is used the recovered image will still lack the necessary information.

In this method, multiple images can be used for Blind Deconvolution when the motion blur functions are different from image to image. The difference of directions of the image is used to recover the PSFs of the blur. Recovering image is done with the following steps.

1] Calculating the motion blur functions

In this stage it is assumed that the motion blur directions are known and the two blurred images are aligned.

The motion blur PSF is recovered by minimizing the error. These recovered PSF are used in deblurring of image.

2] Image deblurring

Iterative deconvolution method is used. The iterative scheme goes as follows based on the gradient decent method

1. Initialize the restored image to the average of input images.

2. Using the gradient function of the error the restored image is updated iteratively.


(a) (b)


(b) (d)

Fig. 1 The advantage of using multiple images for deconvolution. An image was degraded with uniform horizontal (a) and vertical (b) motion blur, and with some Gaussian noise. (c) Deconvolution result considering only image (a). (d) Restoration of image using both (a) and (b) simultaneously.

3] Image alignment

Image alignment is required when multiple images are used to restore the image.

4] Direction of Motion blurs

The directions are determined using a complete search over the angles of the blur functions of both the images.

II.C. lucky imaging

Lucky Imaging is a technique which is useful in astronomical photography. N.M Law *et al*. [7] gives the technique in which number of short exposure images are taken and fusion of only sharp images take place. Lucky imaging is a passive technique so important data is recorded as soon as the telescope is angulated correctly. The Lucky imaging camera prototype can give a very admirable increase in I-band resolution and the signal loss is negligibly less due to frame selection. The data is taken over 10 nights for the system performance. This gives a lucky imaging parameter space defined in terms of camera frame rate, the passband and the telescope size. Algorithm for the selection of frame is as follows:

1. A point spread function (PSF) guide star is taken as a reference to the different blur of the respective frame.
2. The guide star image in each frame is sinc-resampled by a factor of 4 to give a sub-pixel estimate of the position of the brightest patch.
3. A quality factor is calculated for each frame.
4. According to the quality factor a fraction of frames are selected. This fraction is taken to compromise between the signal-to-noise ratio and the resolution.
5. These selected frames are shifted and added to line up their brightest patch position.

Faint guide star PSF are affected by photon shot noise which can be reduced by convolving the faint reference star image with a theoretical diffraction-limited PSF. Drizzle algorithm is used for image alignment step. Lucky imaging offers reliable and very valuable resolution enhancement.

II. PROPOSED METHOD

Camera shake originated from hand vibrations is a random phenomenon which shows that the motion of the camera in an individual image from the burst is independent of the movement in another one [2]. Proposed method based on burst of images. Less blurred part is taken from the burst which is sharper and less noisy than the other images from the burst.

It takes the number of registered images as the input and weighted average of the fourier coefficients of the images in the burst is computed. Three main blocks are considered to built an burst restoration algorithm as shown

A] Burst registration

There are different ways of registering images here image correspondence are used to estimate the dominant homography, which is related to every individual image with the first image in the burst that is the reference image. The homography concept is accepted when the scene is planar or when the location of viewpoint is fixed. SIFT (scale invarient feature transform) is an algorithm to detect and describe local features in images. SIFT is used for image correspondences and then filtering is done using ORSA algorithm.

B] Fourier burst accumulation

When images get registered $\{ vi\}_{i=1}^{M}$fourier transform $\{\hat{vi}\}_{i=1}^{M}$ is directly applied to the registered images. As the camera shake motion kernels have a less spatial support, their magnitudes in fourier domain vary very smoothly. Thus, it is necessary that low pass filtering of [$\hat{vi}$] should be done before computing the weights that is $| \bar{\hat{vi}} | = G_\sigma |\hat{vi}|$, where G_σ is guassian filter having standared deviation σ. The strength of the low pass filter is depend on motion kernel size. As the kernel size is small its fourier spectrum magnitude will be more regular.

The fourier burst aggregation is finalised as:

$$u_p = F^{-1}\left(\sum_{i=1}^{M} wi \,.\, \hat{vi}\right) \quad (6)$$

$$wi = \frac{|\bar{\hat{vi}}|^P}{\sum_{j=1}^{M} |\bar{\hat{vj}}|^P}$$

By using the calculated Fourier weights for all the channels the accumulation is done channel by channel. Arithmetic averaging of Fourier magnitude is used to calculate the weights before the low pass filtering.

C] Noise sharpening

The sharpening must speculate that the reconstructed image may have some unexpected noise. Firstly denoising algorithm is applied the gaussian sharpening is done on filtered image.

III. CONCLUSION

Camera shake spoils precious moments which need to be recover. Different deconvolution algorithm are used to remove the blur of the image. Multi-image deconvolution gives better results than single image deconvolution. The algorithm is presented which removes the camera shake blur in an image burst. An image is restored by fusion of least attenuated frequencies in each frame. The algorithm has several advantages over other deconvolution methods, it does not introduce ringing artifacts. The algorithm works significantly faster and low memory required.

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