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Overcoming Motion Blur: Iris Identification System

Muhammad Khawar Bashir[1], Ali Awais[2], Yasir Saleem[3]

[1]Department of Statistics and Computer Science, FLSBM, University of Vetrinary and Animal Sciences, Lahore, Pakistan.
[2,3]Virtual University, Pakistan

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ABSTRACT

In Iris Identification systems, high resolution images are taken for perfect Iris texture match. High resolution images requires large integration time comparative to low resolution images. When a motion between user and camera is observed, then images taken can be blurred due to motion. The large integration time also blurs the sharp image. Blurred image is result of convolution of latent image and the blur kernel (or point spread function). Our main problem is to estimate correct blur kernel. After that deblurring of an image is just left with a deconvolution operation. We will describe two hardware schemes in which two cameras are used to find motion between consecutive frames. Results of this study ensures that blur Iris images can be enhanced effectively.

KEYWORDS: Motion Blur, Non-blind deconvolution, Blind deconvolution, Point Spread Function, Blur kernel.

1 INTRODUCTION

For last decade, Individual Identification through Iris Matching has become an emerging technology and gaining more attention due to its less false acception rate and accuracy.

For a perfect iris texture match, images are captured under controlled appropriate environment. However, if the environment is not suitable, that is low contrast, low light, low resolution, pupil reflections, off axis gaze, camera angle, and motion blur, then the captured images can have distorted noisy information and conversely, increases false rejection rate (FRR). Motion blur has been a challenging dilemma in Digital Image Processing for recent years. It occurs when a motion between camera and user is observed. Obtaining a sharp latent image from single motion blurred image is a conflicted task.

In case of shift invariant motion blur that is motion consist of just single plane and no rotating motion then the obtained blurry image can be described by convolution of sharp image and PSF. Here PSF elaborates the tracing path of camera or detector.

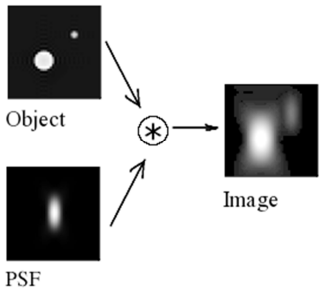

Figure. 1. Point Spread Function.

$$B = I * K + X \qquad (1)$$

*** Corresponding Author:** Muhammad Khawar Bashir, Department of Statistics and Computer Science, FLSBM, University of Vetrinary and Animal Sciences, Lahore, Pakistan.
Email: mkhawarbashir@gmail.com

Where convolution is shown by "∗"operator. B is acquired blurry image when original sharp image I gets convolved with kernel K. Some noise is added also that is shown by X. If blur kernel is known, Then removing motion blur from that image becomes just a deconvolution operation [1]. This process is known as non-blind deconvolution.

For instance if both blur kernel and latent image then deconvolution becomes more confronting. Here in this paper we will dig up blind deconvolution of a single image, where from a single image both parameters (blur kernel, sharp image) are determined. As the motion between user and camera can be fleeting, so motion deblurring is generally considered as blind deconvolution.

2 Blind Deconvolution

For Blind Deconvolution, we must have idea of blur kernel or Point Spread Function (PSF). In this case PSF is not known as well as the original latent image. A vast research has been made for Blur Kernel computation. This is done with help of blind deconvolution.

Blur kernel, that causes sharp picture to become blurred, can be dissolved into simple specific model (e.g. linear movement or circular blur) [2]. These models are characterized by one or two parameters, estimating these parameters may be a tough job. Major drawback is that this approach is not feasible for real world images with more complex kernels with spatially variant kernels.

Estimation of non-blurred image is available with several algorithms. Kernel can be estimated with image statistics. Such algorithms are rarely used because there is nothing known about real ideal image. Richardson - Lucy [3], [4] Iterative method to find unknown kernel or PSF was proposed to extend by Ayers [5] and dainty. Several iterative schemes are available for this algorithm. This method has a major advantage that no information regarding image and PSF is required.

For most real world images, blind deconvolution do not work accurately. In case of complex PSF, it cannot be efficiently applied to deblur images.

3 Hybrid Imaging

This is another technique for PSF estimation. Assume that motion is Shift Invariant that is object is moving just in single plane.

Here two hardware scheme is put forward to approach motion blur problem. First approach, the camera must have optically stabilized lenses. These lenses have adaptive optical characteristics that provide compensation for camera motion [6]. Second approach offers special kind of sensors used to avoid motion blur in which the integration of image is stopped in particular areas where motion is detected Ben Ezra and Nayar [7] proposed another algorithm that finds PSF by measuring motion while integration of image is being processed. And this PSF is later used for image deblurring.

4 Hybrid Imaging System

System employed for hybrid imaging has two cameras with different characteristics. There are two main characteristics of a digital camera: 1) number of pixels (spatial resolutions) and 2) number of images (or frames) per unit time. A digital cam has an image detector with number of pixels detectors. During image integration time, these pixels receive light energy. To acquire a sharp image, light received by each detector must be greater than a threshold value. So exposure time is inversely proportional to the number of pixels. Greater the spatial resolution, larger is the exposure time and vice versa. In terms, spatial and temporal are inversely proportional to each other.

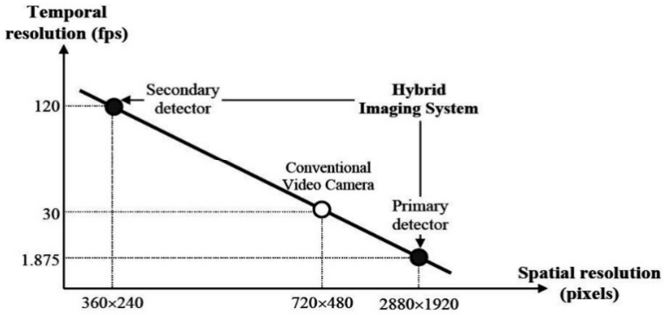

Figure. 2. Temporal Resolution v/s Spatial Resolution.

To find the PSF in an image, we can use two cameras, one with large spatial resolution and other with large temporal resolution. The camera with large spatial resolution will have large exposure time and will suffer from blur while the other camera with low spatial but large temporal resolution will not undergo motion blur because images taken with this camera after very short time intervals. This lower spatial resolution image sequence is used to calculate kernel using deconvolution.

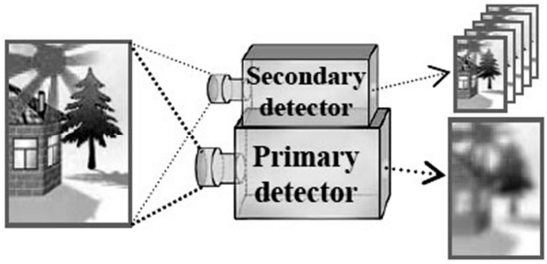

Figure. 3. Hybrid Imaging System.

Video camera is made black and white, that increases its temporal resolution.

5 Motion Calculation

A Frame sequence provided by low resolution (high temporal) camera taken at particular time intervals in exposure time can be employed to trace motion path of user or object.

First of all, motion trace between consecutive adjacent frames is computed. This difficulty is regarded as image registration. But we cred it earlier that the motion is just in single plane and no rotational motion, so we are left just with translational motion registration dilemma.

An iterative approach was established by B. D. Lucas and T. Kanade [8] to find motion between two successive frames by Newton - Raphson iterative method. In this method, derivatives of images are calculated. This can be applied to real world photographs because it's easier to calculate derivatives. For applications to sharp images, sophisticated techniques should be applied for computing derivatives. Here this method becomes less efficient.

6 Estimating PSF

After computing motion between successive images, disparity vectors can be added successively to obtain motion path function's discrete samples [9]. Next we have to manipulate these samples to compute motion path.

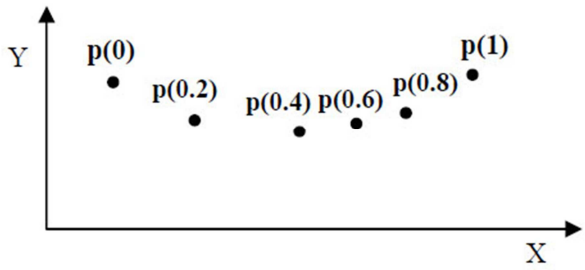

Figure. 4. Discrete motion samples.

Ben Ezra – Nayar [7] recommended spline interpolations because these curves are twice differentiable and smooth which satisfy both the acceleration and speed constraints.

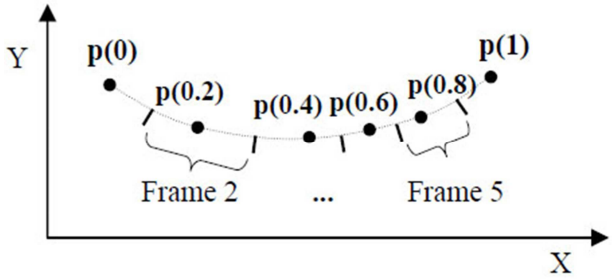

Figure. 5. Interpolated path p (t) segmented by Voronoi tessellation.

Now to compute energy function, magnitude of each image is found along the trajectory we estimated before. So we split the path into portions with one dimension VoronoiTesselation [10]. These portions describes motion while integration of images captured by secondary camera. As all images are captured with same exposure time, the view refulgence remains unchanged, that is each portion has same level of energy integrated. We can say that energy of a portion and portion length are inversely proportional to each other and vice versa.

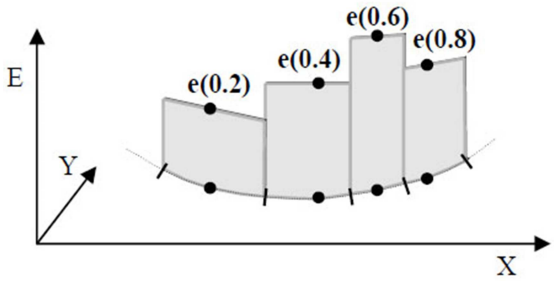

Figure. 6. Energy estimation for each frame.

After converting PSF into parametrs, we convert it into matrix form with help of PSF computation algorithm described in Johannes Brauers et al [11]. Then we can apply deconvolution algorithm. Ben Ezra – Nayar [7] applied Richardson – Lucy [3], [4] methods though it is robust against minor errors.

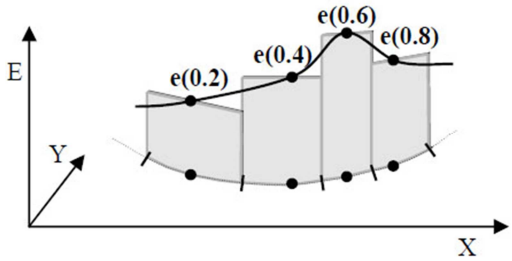

Figure. 7. The smoothed energy function e (t).

7 RESULTS

Deblurring algorithms applied to a blurred image taken with high resolution camera is shown in figure 8.

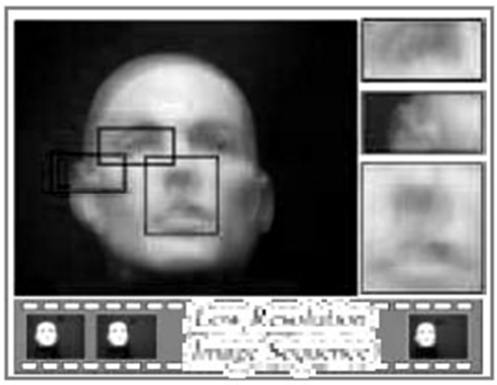

Figure. 8. Motion Blurred Input Image.

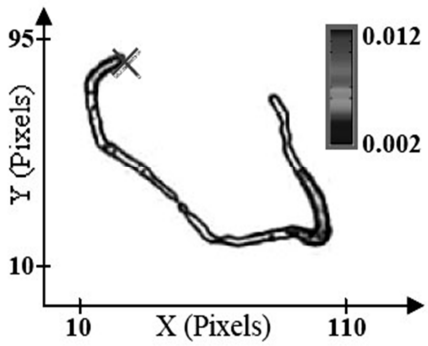

Figure. 9. Computed PSF.

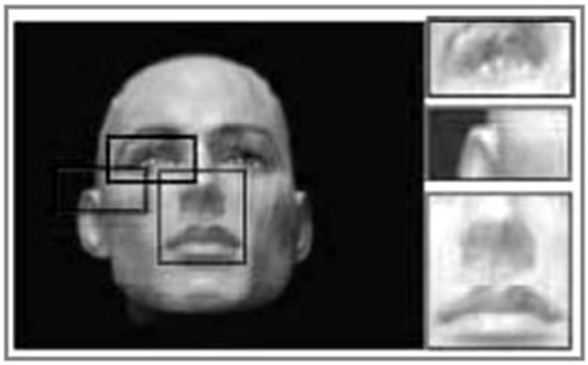

Figure. 20. Restored Image.

The obtained latent image has significant improvement in quality. Performance can of algorithm can vary with the selection of different processors [12].

7 Conclusions And Future Work

Significant improvement in image quality is observed. Deconvolution artifacts and noise are side effects of deconvolution. This image can be used to match with database and false rejection rate is decreased and system accuracy is increased.

Here we had a convention of shift invariant motion blur and the blurring function is spatial invariant over the whole image in this case.

However, a more complex situation is when an object is moving while the background is stationary. Here the PSF is not spatial invariant. Just the moving part of image is blurred. Reduced fuzzy rules [13] can also be tested for this complex situation.

Hybrid imaging is a low cost technique that can easily approached by consumer level cameras by simply placing low cost chip inside camera.

Also, Primary and secondary camera can also be made on same chip having high resolution in center while outer boundary with low resolution. This chip can be made using binning techniques.

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