Enhancement of Image Quality in MATLAB Environment – Super-Resolution

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Abstract— The Super-Resolution is one of main topics in image processing many applications in past, recent today's and future. This paper focuses on super resolution of images using difreent type of Enhancment of Image Quality in MATLAB Environment – Super-Resolution algorithms. We have improved the performance of involved stages such as Registration, Interpolation, Reconstruction and Restoration and for different image quality measures.Results shows the resolution improvement in Spline Cubic Spline SR Method , Robust SR Method and Fast & Robust SR Method.

Keywords- Registration, Interpolation, Reconstruction, Restoration, Cubic Spline SR Method , Robust SR Method , Fast & Robust SR Method, Sampling, Warping, Deblurring.

I. INTRODUCTION

The main aim of Super-Resolution (SR) is to generate a higher resolution (HR) image from lower resolution (LR) images obtained from a same scene with sub-pixel shifts. HR image means that pixel density within an image is high. In diffreent varity of application image processing plays a important role in recent years. We require HR in different computer applications for better performance in analysis of images prodedure and patteren recognition process. Now a days most important and emerging fields of medical require HR images.HR image is very important in medical imaging application for a doctor to make a correct diagnosis.Hence HR images very helpful in medical imaging application and now days in medical fields typically suffer from one of more of the following imperfection such as low resolution (in the spatial and spectral domains), high level of noise, low contrast, geometric deformations, presence of imaging artefacts. Many more imaging applications require zooming of a specific area of interest in the image where in high resolution becomes essential, e.g. surveillance, forensic and satellite imaging applications.

In most electronic imaging applicatios, images with HR are desired and often required. Hence now days key researchers domain is image enhancement, especially to improve the resolution of images. Image resolution defined as the smallest perceptible or weighable detail in a visual representation and the process of obtaining a high resolution image from a set of low resolution observations is called super-resolution imaging. It means that pixel density within an image is high, and therefore an HR image can offer more details that may be critical in various applications.In SR, the sub-pixel shifted in LR images can be obtained from one camera with several captures or multiplescene can be obtained from one camera with several captures located in different positions.Thus the recorded image usually suffers from blur, noise and aliasing effects,although the main conceren of an SR algorithm is to reconstruct HR images from undersampled LR images.

II. OBSERVATION MODEL

The first step to understand SR is to formulate an observation model to relate the LR images to the desired HR image.A scene with continuous intensity distribution $\underline{P}$ is seen to be warped at the camera lens because of the relative motion between the scene and camera. For extensive analysis of SR image reconstruction problem,the required thing is to formulate ,an observation model that relates the original HR image to the observed LR images.The images are blurred by atmospheric disorder and camera lens by continuous point expanded functions $H_k = H_k^{cam} H_k^{atm}$. Then, they will be discretized using CCD sensors systems which results in a digitized noisy frame $\underline{Q}$. We reprsent this forward model by equation (1).

$$\underline{Q}_k = D_k F_k H_k \underline{P} + V_k \qquad k = 1, 2, \ldots, N \tag{1}$$

Where the camera's point spread function (PSF), is modeled by the blur matrix H_k, and D_k represent the decimation operator. F_k is the geomatric warp operator between the HR frame P, the k_{th} LR frame $\underline{Q}_k$ which are rearranged in lexicographic order (P and Q_k present their matrix from). V_k is the additive noise and N is number of available LR frames. Fig. 1 illustrates equation (1).

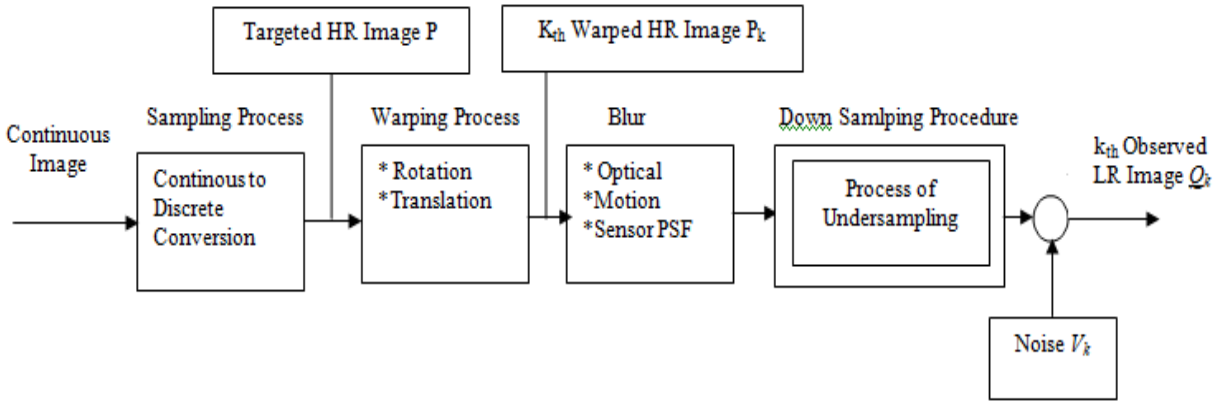


Fig 1.Observation Model relating LR images to HR Images

III. SUPER-RESOLUTION ALGORITHMS

The algorithm implemented in this paper is robust super-resolution.In the Robust super-resolution method to estiamtion of an unknown high resloution image is not exclusively based on the low resolution measurments.It is also base on many asumptions based such as noise or motion.The Robust super-resolution method are robust estimation is concepts of robust,error in modelling,error in motion,inconsistent pixels and noise.The data fusion is blurred high-resolution image from the low-resolution is finding and estimation the deblurred image and estimating the deblurred image.In super resolution cases ($p < r^2$ in which p is th non-redundant low-resolution frames of number and r is enhancement resolution factor) and thepixel locatios will not estimate at all.In interpolation the adding a regularization term to calculating missing data.in robust regularization is a very usful in the squar and determined cases ($p = r^2$ and $p > r^2$ respectively) and also reregularization very help the algorithm to remove artifacts from the final answer & improve the rate of convergence. The following expression formulates our minimization criteria (2).

$$\underline{\hat{P}} = \underset{\underline{P}}{ArgMin} \left[\sum_{k=1}^{N} \left\| D_k H_k F_k \underline{P} - \underline{Q}_k \right\|_1 + \lambda \sum_{l=0}^{P} \sum_{m=0}^{P} \alpha^{m+l} \left\| \underline{P} - S_x^l S_y^m \underline{P} \right\|_1 \right] \quad (2)$$

λ is a scalar to weighting the first term (likeness cost) against the second term (regularization cost). S_x^l is the operator to horizontal direction way shifting P by l pixels and S_y^m is operator to shifts P by m pixels in vertical direction way, (presenting a few scales of derivatives. Scalar weight α, $0 < \alpha < 1$, spatially decaying effect to the summation of the regularization term is applied. This method is accountable for deblurring –intepolation , non iterative artifical removes ,blur, a edge preservation as well as seeks robustness with respect to motion error, outliers, and other kinds of errors not explicitly modeled in the fused images. The steps of Robust SR method is load the low resolution iamge in the .mat format then it is registertion the images with shifting of pixels using pyramidal LK optical flow process with resolution factor increase. The funtion uses the steepest descent and method to minimize the super resolution cost function which includes terms is “energy" term, which is the L1 norm of the residual error between the HR image and the LR imag sequence .The "regulerization" term which induces piecewise smoothness on the HR image using the bilateral filter. The PSF fuction common to all frames and space inveriant.The property structure used to control the algorithm parameters. It then uses the bilateral filter as a regulating term for the debluring and interpolation step then it estimated high resolution image.

In this method, the resolution enhancement is broken into two consecutive steps:

1) Non-iterative data fusion process.

2) Iterative de-blurring interpolation process.

In the Fast & Robust SR method the function first computes an estimation of the blurred HR image, using the median and shift method. . It then uses the bilateral filter as a regulating term for the debluring and interpolation step. The fast & Robust SR method is load the low resolution iamge in the .mat format then it is registertion the images with shifting of pixels using pyramidal LK optical flow process with resolution factor increase. The tranlational motion for each LR frame. The PSF fuction common to all frames and space inveriant.The property structure used to control the algorithm parameters then it estimated high resolution image.The following expression (3) use in it.

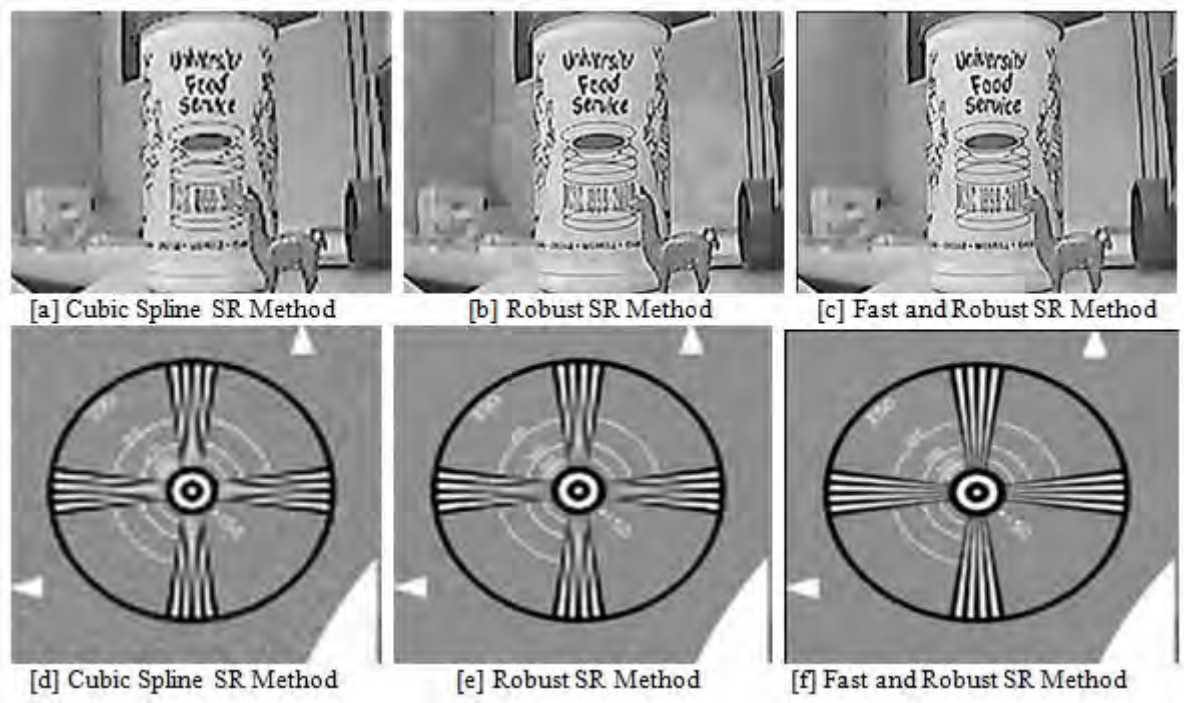
$$\underline{\hat{P}} = \underset{\underline{P}}{ArgMin} \left[\left\| H\underline{P} - \underline{\hat{R}} \right\|_1 + \lambda' \underbrace{\sum_{l=-P}^{P} \sum_{m=0}^{P}}_{l+m>=0} \alpha^{|m|+|l|} \left\| \underline{P} - S_x^l S_y^m \underline{P} \right\|_1 \right] \quad (3)$$

In the Cubic –Spline SR method implements a cubic spline interpolation of a single image.This image is then deblured.It interpolation on the low resolution frame the input sequence.Super-resolution reconstructin is image interpolation that has been used to incrase the size of single image. Non uniform interpolation is used to produce an improved resolution image and deblurring process.The steps of Cubic –Spline SR method is load the low resolution iamge in the .mat format then it is registertion the images with shifting of pixels using pyramidal LK optical flow process with resolution factor increase.The PSF fuction common to all frames and space inveriant.The property structure used to control the algorithm parameters .The compute super resolution using cubic spline and deblur spline super resolution interpolation after that mapping to high reslotion with deblurring.The first computes an estimation of the blurred HR image, using the median and shift method. It then uses the bilateral filter as a regulating term for the debluring and interpolation step then it estimated high resolution image.

IV. EXPERIMENTS

We have studied the performance of three resolution enhancement algorithms. Low resolution frames oreder created using one high resolution image as shown in Figure. First, in high resolution image by a pixel shifted in the vertical direction.Then, after to simulate the camera PSF effect, convolved with a symmetric Gaussian low-pass filter of size 4X4 with standard divergence equal to one by shifted image. The resulting image was sub sampled by the factor. The same approach with different motion vectors (shifts) in vertical and horizontal directions was used to produce low resolution images from the original scene. The low resolution frames are shown in Figure. The sequence of low resolution frames is used for these three algorithms .The super-resolved images for Cubic SplineSR method is shown in Fig.2 (a,d,g,k), Robust SR method is shown in Fig.2 (b,e,h,l) and Fast &Robust SR method in Fig.2 (c,f,i,m). The results and study shows the improvement in resolution factor and Quality in Fast &Robust SR method.The super resolution parameters resolution factor, PSF kernel size, PSF sigma, Alpha, Beta, Lambda and Iterations were also computed.

V. RESULTS



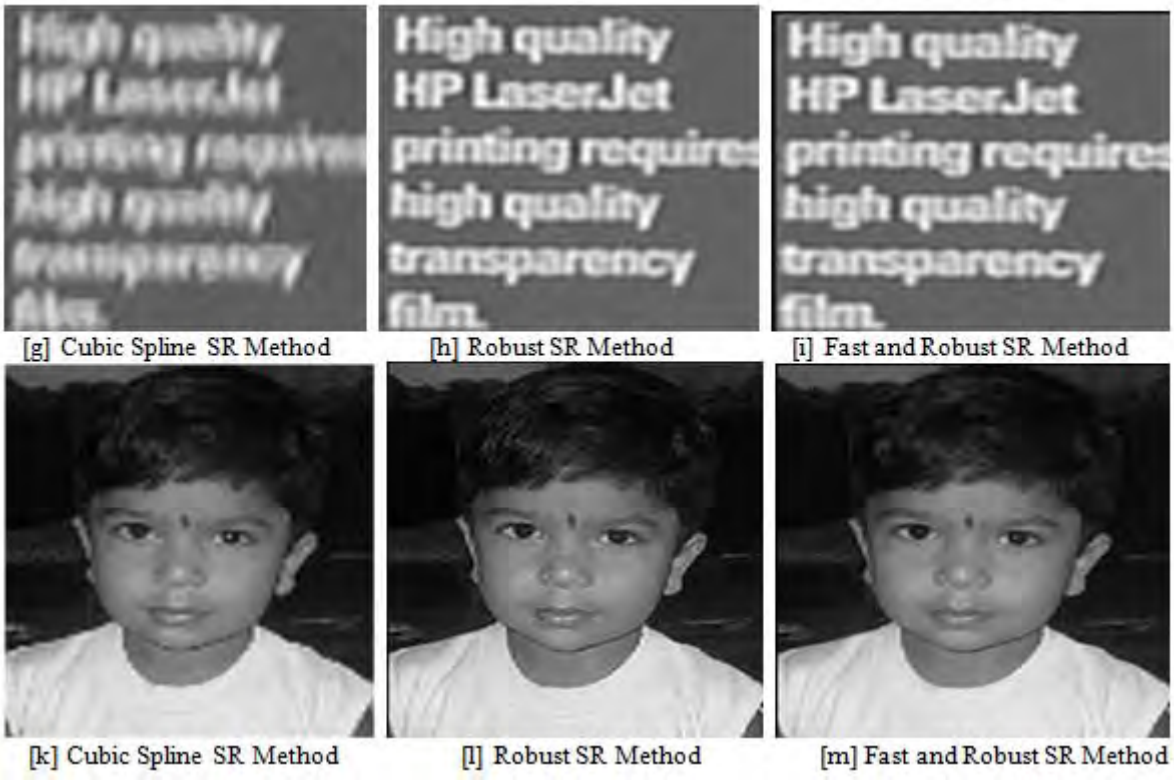


Fig. 2. Super-Resolved Images generated using Cubic Spline SR Method, Robust SR Method and Fast & Robust SR Method from set of LR Images.

VI. CONCLUSION

In this paper, the results shown are implemented in MATLAB and GUI is developed for image Super-resolution. The study shows the improvement in the quality of LR images by using the above mentioned three super-resolution algorithms.

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