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A Novel Approach for Image Registration Along with Simultaneous Interpolation and Restoration for Super Resolution Image Reconstruction

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ABSTRACT: Reduction of noise and blur in the super resolution process is a challenge task in reconstruction. These factors reduce the quality of the image. In this paper we presented a novel approach based on a combination of MSIFT – IM-RANSAC for registration is proposed along with interpolation of image in the HR grid by preserving edges and Finally MRF Regularization is implemented to sharpening the edges during image restoration . Based on the experimental results the proposed method is compared with quality metrics such as PSNR, SSIM and MSE values with various methods and results showed that our method is better than others.

KEYWORDS: SIFT, PCA-SIFT,SURF,ASIFT, SSIM, MSE ,PSNR

I. INTRODUCTION

Super resolution refers to produce high quality (high resolution) images from a set of low quality images (low resolution images). Naturally there is always a demand for better quality images. However, the hardware for HR images is expensive and can be hard to obtain. The resolution of digital photographs is limited by the optics of the imaging device [2].In conventional cameras, the resolution depends on CCD sensor density, which may not be sufficiently high. As the image-capturing environment is not ideal, many distortions are also present in the low-resolution images [4] .They may have blurred, noisy, aliased low resolution captures of the scene. Therefore, a new approach is required to increase the resolution of the image. It is possible to obtain an HR image from multiple low-resolution (LR) images by using the signal processing technique called super resolution. There are three major steps in super resolution i.e., image registration, interpolation and restoration. Accurate image registration is an important factor in super resolution performance. The demand for accuracy in image registration is increasing because of the super resolution applicability in various fields. There is a great deal of the image registration research in the literature. There are several super resolution reconstruction methods are used to improve resolution of a images, Tsai and Huang were the first to consider the problem of obtaining a high-quality image from several lower quality and translation ally displaced images in 1984 [5]. Their data set consisted of terrestrial photographs taken by Landsat satellites. Super resolution is a process of increase the quality of image. Now a day's Image restoration plays a major role. It is a well defined process of visually increase the quality of image and focus on clipping of unwanted effects which accomplished during the image capturing. For instance, de-blurring, de-noising methods are used to cancel or minimize those effects. Neither of these methods is able to increase the spatial resolution of the images [6, 7] Nevertheless, without image restoration and interpolation one cannot understand the concept of super resolution. In this study, an image super-resolution (SR) reconstruction approach SIRIR is proposed. The proposed method consists of three stages namely, sub pixel shift for feature extraction and worst feature elimination by modified ASIFT algorithm , extracted feature interpolation by nearest neighborhood method and Sharpening the edges using MAP based Markov random field regularization.

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II. RELATED WORK

The procedure of Scale-Invariant Feature Transform SIFT mainly includes three steps: key point detection, descriptor establishing, and image feature matching. Most of the researchers improve the performance of SIFT by adjusting these steps. In the phase of descriptor establishing, SIFT algorithm uses a 128- dimensional vector to describe each key point. This high dimension vector to describe each key point slow down the image feature matching step. In order to reduce the dimensionality of describing each key point, Y. Ke [13] uses the Principal Component Analysis method to replace the SIFT algorithm as PCASIFT. J. M. Morel [15] proposed Affine-SIFT (called ASIFT), which make use the parameter of affine transformation to strongly resist affine issues and intends to correct images. Generally, extracting the useful feature in the image is a challenging task in the image processing. It is used to detect the point of interest of the image. According to Lowe.D [17] more than 12,000 references are available among those references, the numbers of references of SIFT [12] PCA-SIFT [15],ASIFT [15] and SURF [18] are relatively high. SIFT only describes local information in the phase of descriptor establishing, and does not make use of global information. E. N. Mortensen [14] introduced a SIFT descriptor with global context (called GSIFT), which adds a global texture vector to the basis of SIFT. H. Bay [16] proposed SURF which adopts different processing methods in every step but it is very similar to SIFT. H. Bay claimed that SURF is an enhanced version of SIFT.

III. OBSERVATION MODEL

Even though Super resolution of an image can be obtained through various steps the first and foremost process is to formulate an observational model from the desired High Resolution Image. So we start by modeling a problem to get the Low Resolution image from the High Resolution image. Figure [1] shows the commonly used observational model in the literature [1,3]

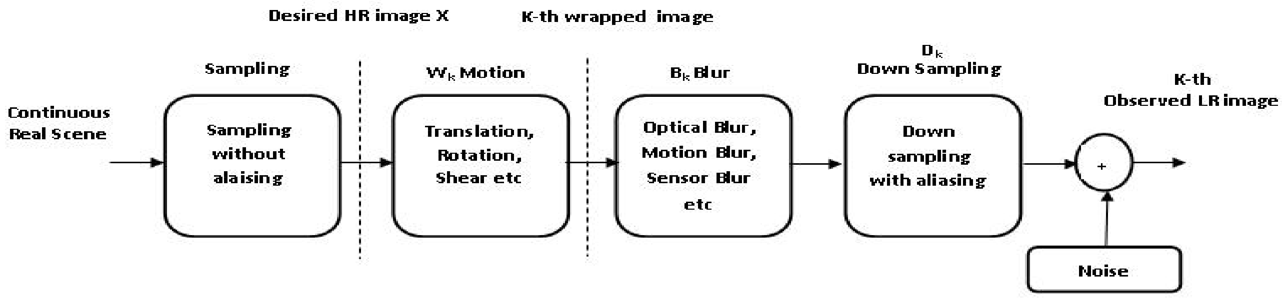

Fig. 1. Observational Model

Assuming that the size of the desired HR image is W × H where W and H are its width and height respectively. The HR image can be rewritten in lexicographical order as the vector z where $z = [x_1, x_2, \ldots x_N]^T$ where N= W x H.

The vector x is a degraded image that is sampled from the continuous real world scene capture by a camera. These images are blurred because of several camera limitations. The finite sensor size results in sensor blur, the finite aperture size causes optical blur, the insufficient shutter speed causes motion blur[10]. The blurred images are further down sampled by the sensor into pixels. The spatial resolution of the acquired images is limited by the sensor density which can lead to aliasing effect. Further assuming that each observed images is contaminated by Gaussian noise. Therefore, the final images are warped, blurred, down sampled and noisy versions of the real scene described by the vector x.

Let y_k denotes the kth LR image represented as $y_k = [y_{k,1}, y_{k,2}, \ldots y_{k,M}]^T$, where $k = 1,2, \ldots, p$, with p being number of LR images. The observational model can be defined by the equation

$$y_{k=} D_k B_k M_k x + n_k \ for\ 1 \le k \le p$$

Where p is number of LR images. Here D_k is decimation sub sampling matrix, B_k is the linear space variant blur matrix, M_k is a matrix representing the motion model and n_k is white Gaussian noise being encountered in the observation model.

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IV. Proposed Approach

Existing super resolution methods attempt to reduce the effect of estimation errors and noise in restoration process. They do not attempt to correct the errors in the registration and interpolation process. (Such as motion blur, artifacts, edge preserving etc.). In this proposed method we deal with noise and blurring related problem in edges region to preserve edges by Simultaneous Image Registration, Interpolation and Restoration approach.

Proposed algorithm is proceeds as follows

Input: Reference Image and Observational Low Resolution Image.

1. Affine distortion using latitude θ and longitude Ø angle sampling for the two images.
2. Apply tilt t=1/cos(θ) to the image after performing image rotation with angle Ø.
3. Perform affine transformation for both the images using the equation

$$A = \lambda \begin{bmatrix} \cos\psi & -\sin\psi \\ \sin\psi & \cos\psi \end{bmatrix} \begin{bmatrix} t & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} \cos\phi & -\sin\phi \\ \sin\phi & \cos\phi \end{bmatrix}$$

   Where λ is the scale factor ψ is the angle between the camera and the optical axis
4. Extract and match the feature vectors using affine scale invariant feature transform.
5. To eliminate mismatched feature points, such as, the transformational matrix is chosen as the objective function. Reference image I and target image C satisfy the affine transformation relationship, such that:

$$\begin{cases} u = a_1 x + a_2 y + t_1 \\ v = a_3 x + a_4 y + t_2 \end{cases}$$

   where I (x,y) and C (u,v) represent a feature point of reference image I and collected image C, respectively
6. Projecting the image in high resolution grid using non linear bilateral filtering. It can be represented by the following equation

$$\mathbf{h}(x) = \frac{1}{k(x)} + \sum_{y} \mathbf{I}(\mathrm{y})\mathrm{c}(\mathrm{x},\mathrm{y})\mathrm{s}\big(\mathbf{I}(\mathrm{x}),\mathbf{I}(\mathrm{y})\big)$$

   Where I and h are the input and output images respectively, x and y are pixel positions over the image grid, c(x, y) and s(I(x), I(y)) measure the spatial and photometric affinity between pixel x and pixel y respectively, and

$$k(x) = \sum_{y} c(x,y)s\big(\boldsymbol{I}(x),\boldsymbol{I}(y)\big)$$

7. Formulate a MAP-MRF for reconstruction.

V. Experimental Results

We evaluate the performance of our approach with other registration and interpolation methods such as SIFT,PCASIFT,SURF,ASIFT and Bilinear, Bi-cubic, NN ,EDI respectively by MAP-MRF Reconstruction. The result is compared with quality metrics of an image (ie. SSIM, MSE ,PSNR) and it shows that our approach produce better resolution.

	MAP- MRF RESTORATION (MSE)				
	Bilinear Interpolation	Bicubic Interpolation	NN method	B-Spline	Non linear Bilateral Interpolaton
SIFT	82.3932	137.466	96.2937	160.073	64.5905
SURF	138.149	168.883	138.603	180.551	136.409
PCA-SIFT	96.8941	131.141	105.187	145.649	104.729
ASIFT	160.644	182.257	156.681	190.543	182.545
Proposed	190.707	202.476	185.841	208.516	256.209

Table 1 .MSE Comparison

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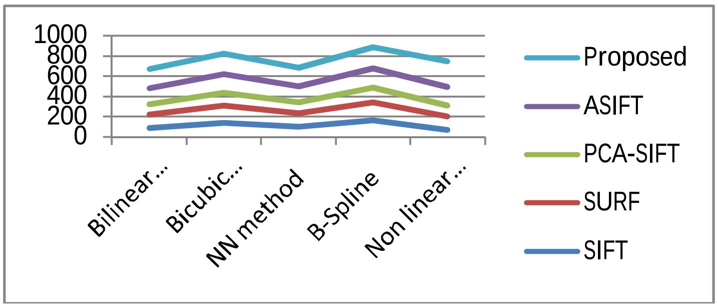

Fig .2. MSE Comparison Chart

	MAP - MRF RESTORATION (PSNR)				
	Bilinear Interpolation	Bicubic Interpolation	NN method	B-Spline	Non linear Bilateral Interpolaton
SIFT	28.9719	26.7489	28.2948	26.0876	70.0291
SURF	26.7273	25.8549	26.7131	25.5648	66.7824
PCA-SIFT	28.2678	26.9534	27.9112	26.4977	67.9301
ASIFT	26.0722	25.524	26.1807	25.3309	65.5171
Proposed	25.3271	25.0671	25.4394	24.9394	64.0449

Table 2 .PSNR Comparison

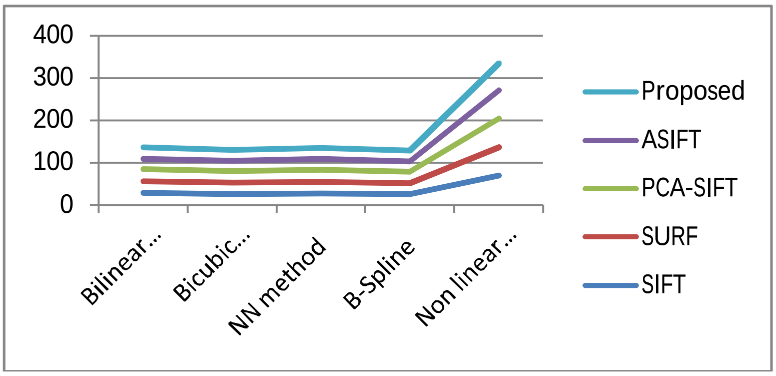

Fig .3. PSNR Comparison Chart

	MAP - MRF RESTORATION (SSIM)				
	Bilinear Interpolation	Bicubic Interpolation	NN method	B-Spline	Non linear Bilateral Interpolaton
SIFT	0.413909	0.344839	0.358375	0.32534	0.0932214
SURF	0.342987	0.287273	0.300971	0.26605	0.152013
PCA-SIFT	0.355622	0.302703	0.311462	0.28552	0.107716
ASIFT	0.322694	0.264232	0.280613	0.24271	0.190499
Proposed	0.303258	0.236998	0.258265	0.21472	0.230997

Table 2 .SSIM Comparison

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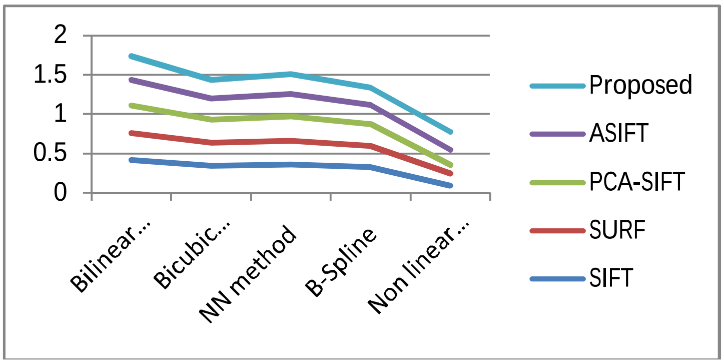

Fig .4. SSIM Comparison Chart

VI. CONCLUSION

In this paper, we propose a novel approach for image registration using MSIFT-IM-RANSAC along with simultaneous interpolation and restoration is performed. This technique is compared with registration techniques such as SIFT,PCASIFT,SURF,ASIFT and interpolation techniques Bilinear, Bi-cubic, NN ,non linear bilateral interpolation. After interpolation MAP-MRF Reconstruction is applied to the interpolated image and the result proved that our proposed techniques perform well with non linear bilateral interpolation technique. Based on the quality metrics SSIM ,PSNR&MSE of an image produced by our method showed best results than all other methods. The advantage of proposed method is that it preserves edges even after interpolation which results in increase of visual quality of the image.

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