PRINCIPAL COMPONENT ANALYSIS BASED SUPER RESOLUTION RECONSTRUCTION

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Abstract : In many surveillance video applications, it is of interest to recognize an object or a person, which occupies a small portion of a Low-Resolution [LR], noisy video. Hence to enhance the Image quality and the resolution of the Image, Super Resolution [SR] Image Reconstruction Algorithm is used. An efficient Image Super Resolution [SR] methodology using Principal Component Analysis [PCA] is applied to obtain a High Resolution [HR] image from a set of low resolution video frames. The Super Resolution [SR] methodology involves mainly four basic steps such as Registration, Fusion, Interpolation, and Restoration. In this project, the Low Resolution [LR] images are registered by using Scale Invariant Feature Transform method. The registered images are fused by using Principal Component Analysis method.

Index Terms **– Low resolution, Super Resolution, Interpolation, Registration, Principal Component Analysis.**

I. INTRODUCTION

Super resolution is a process in which a high-resolution image from one or more low resolution image is produced. In the imaging process, it is possible to image detail high frequency components lost for several reasons, including the low number of camera sensory cells, ambient light from different elements, camera movement and not adjust the camera focal point [1-3]. The super resolution is an attempt to retrieve the image details that are lost[4]. Today advances in computers with high accuracy and processing power, has caused more attention to be software based super-resolution methods[5-6]. Super resolution is used in monitory systems such as identification and recognition of license plates, face recognition, automatic target recognition and, remote sensing, medical image processing such as CT and MRI and , converting video to different standards, image enhancing, processing of satellite images, astronomical image processing, microscopic image processing and image mosaicking[7-9].

Overview:

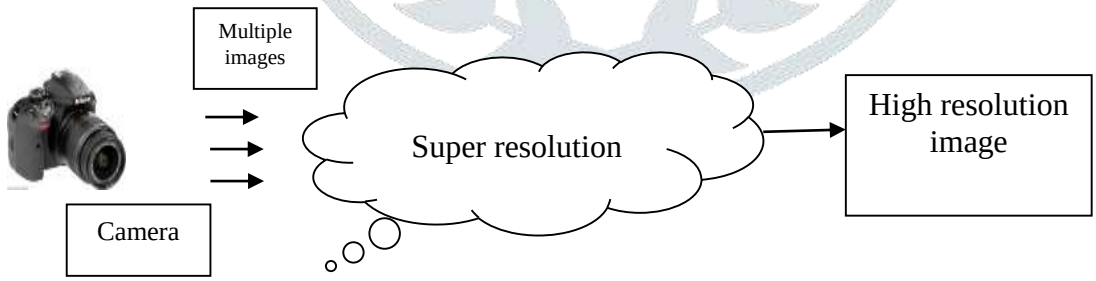


Fig.1. Block diagram for object recognition in surveillance systems

 Super resolution – The obtained images are in low resolution, they need to undergo many steps to increase its resolution. The basic steps of super resolution are Registration, Fusion, Interpolation, Restoration.

 High resolution image – The image which undergoes all the steps of super resolution will have high resolution. The image thus obtained can be compared to the data base images.

II. BASIC STEPS OF SUPER RESOLUTION

The following were the stages in the formation of a high resolution image from multiple low resolution images using super resolution.

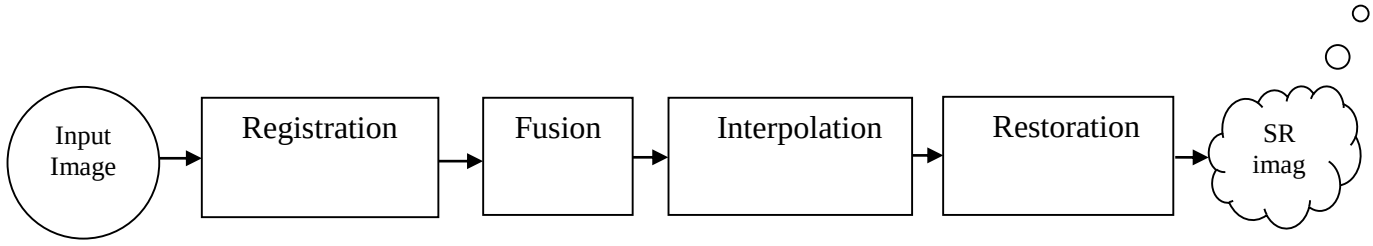


Fig.2. Block diagram for super resolution

IMAGE REGISTRATION

image registration is the process of transforming different sets of data into one coordinate system. data may be multiple photographs, data from different sensors, times, depths or viewpoints. registration is necessary in order to be able to compare or integrate the data obtained from these different measurements.

image fusion

In computer vision multi sensor image fusion is the process of combining relevant information from two or more images into single image. The resulting image will have information more than any of the input images.

The fusion methods such as averaging principle component analysis (PCA) fall under spectral domain fusion methods. The disadvantage is of spectral domain approaches is the produced spatial distortion in fused image. The discrete wavelet transform has become a very useful tool for fusion. Singular value decomposition gives better result than any other method.

AVERAGE BASED FUSION METHOD

In this SR reconstruction technique utilizes the simple average based fusion. Averaging fusion comes under arithmetic fusion algorithm which is very simple and effective in nature. The fused image is obtained as an arithmetic combination of the corresponding pixel intensities in the input images and is expressed as

$$I_{fused}(x, y) = K1\ I1(x, y) + K2\ I2(x, y) + C \quad \ldots\ldots\ldots \quad (1)$$

Where I_{fused} is the resultant fused Image, 1_1 & 1_2 are the input images to be fused and K_1, K_2 & C are constants. For simple averaging method K_1 & K_2 are 0.5 and C=0.

PRINCIPAL COMPONENT ANALYSIS (PCA) FUSION METHOD

The PCA which is a variable reduction procedure and is suitable for the development of smaller number of variables from the obtained measures on a number of observed variables. These variables are called the Principal components, those account for most of the variants in the observed variables i.e., most of the information lies in the observed variables. The variance captured by the principal components will give the same result as the original with all observed variables, PCA can identify the strongest patterns in the image and thus helps in reducing the complexity by reducing the variables and also removes the noise in the dataset.

INTERPOLATION

Image interpolation is the process by which the number of pixels comprising an image is increased to allow printing enlargements that are of higher quality than photos that are not interpolated. Interpolation is commonly needed to make quality large prints from digital photos and film scanned images.

NEAREST NEIGHBORHOOD INTERPOLATION

One of the simplest interpolation algorithms is nearest neighbor interpolation. In this method, the pixel address is discarded, and the pixel brightness value at the resulting integral address in the source image is copied to the zoomed image.

BILINEAR INTERPOLATION

An interpolation technique that reduces the visual distortion caused by the fractional zoom calculation is the bilinear interpolation algorithm. Bilinear interpolation produces pseudo resolution that gives a more aesthetically pleasing result, although this result is again not appropriate for measurement purposes.

BI-CUBIC INTERPOLATION

The technique of Bi-cubic interpolation produces less blurring of edges and other distortion artifacts than bilinear interpolation, but is more computationally demanding. Bi-cubic interpolation involves fitting a series of cubic polynomials to the brightness values contained in a 4 x4 array of pixels surrounding the calculated address.

IMAGE RESTORATION

The most straightforward and a conventional technique for image restoration is de-convolution, which is performed in the frequency domain and after computing the Fourier transform number of both the image and the PSF and undo the resolution loss caused by the blurring factors. This de-convolution technique, because of its direct inversion of the PSF which typically has poor matrix condition number, amplifies noise and creates an imperfect de-blurred image.

III. PCA BASED SUPER RESOLUTION METHOD

Super-resolution is based on the idea that a combination of low resolution (noisy) sequence of images of a scene can be used to generate a high resolution image or image sequence. Thus it attempts to reconstruct the original scene image with high resolution given a set of observed images at lower resolution. The general approach considers the low resolution images as resulting from resampling of a high resolution image.

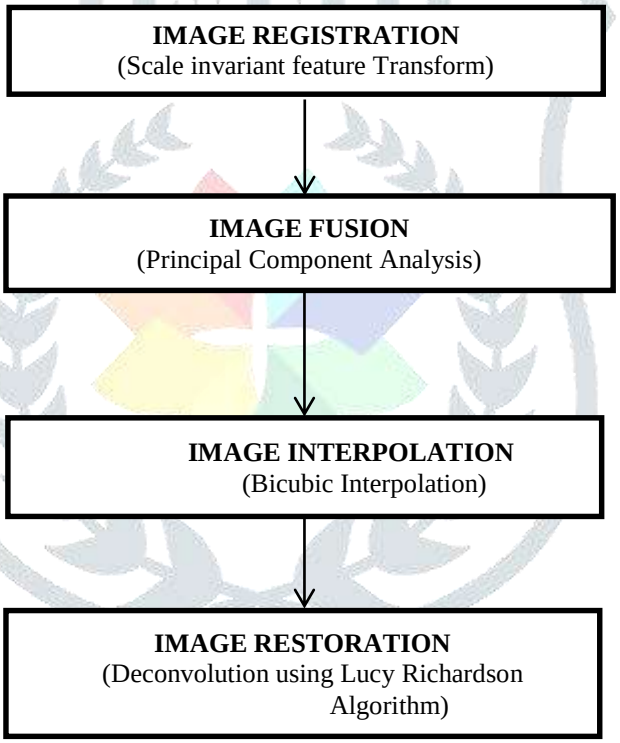
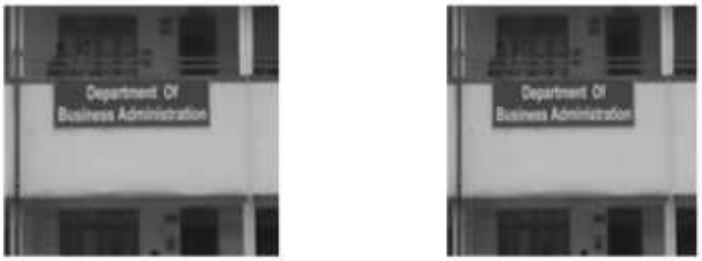


Fig.3. Flow chart of PCA based Super Resolution

IV. RESULTS

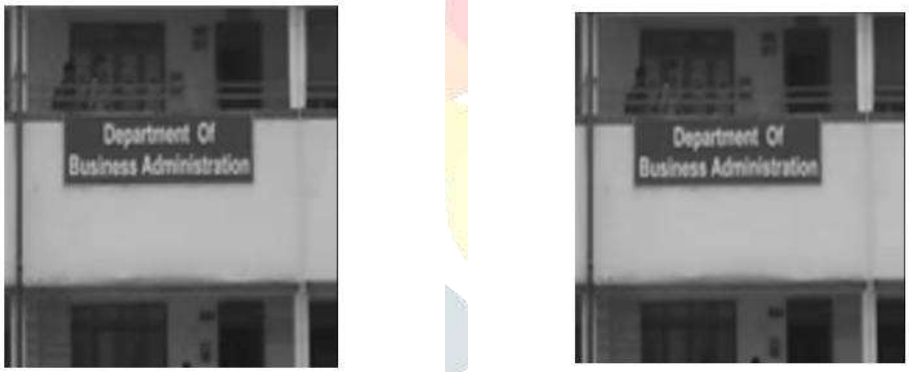
A set of images are taken from a sample video, RGB to gray transform is applied to it and the required portion was cropped from the images. Then the set of images are registered with the reference image and then the set of registered images are obtained. These registered images are fused to form an image having more information than the original image. But the image is still blurred, in order to increase the number of samples interpolation need to be applied. The interpolated image has to be restored by relating the intensity of interpolated image to the original image.

(a) (b) (c)



(d) (e)

Fig. 4. Input images from sample video



(a). (b).

(c). (d).

Fig.5. Registered images

The four registered images are obtained when four images are registered with the reference image. The table shown below shows the scale and angle of each of the registered image. It is nothing but the difference between the reference and registered images.

Table.1. Scale and angle of registered images.

Registered image	Scale recovered	Theta recovered
Image 1	0.9996	-0.0355
Image 2	0.9996	-0.2075
Image 3	0.9968	-0.1537
Image 4	0.9977	-0.1112

Fig.6. Fused image

It is obtained by fusing the first registered image with reference image and then the resultant image is again fused with the second registered image and process continues to obtain the final image.

Fig.7. Interpolated image

It increases the number of samples in the final image obtained after fusion and enlarges the image size.

Fig.8. PCA based Super Resolution method output

The final restored image is obtained by matching the intensity values of interpolated image with the original image. It reduces the noise and smoothen the image.

PSNR Value = 15.6783 dB

V. CONCLUSION

An efficient Principal Component Analysis based Super Resolution Reconstruction algorithm is used to obtain the HR image from the set of LR images. The Super Resolution techniques are Registration, Fusion, Interpolation, Restoration. In this project, the Low Resolution images are registered by using Scale Invariant Feature Transform method. The registered images are fused by using Principal Component Analysis method. The resolution of image is increased by using Bicubic Interpolation and deconvolution method of Restoration is used to recover the original image. By applying the Super Resolution technique to an image the obtained output image will be more clearer and informative i.e., we get more details from the image that are lost.

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