

# Analysis of Multi Frame Super Resolution Methods

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## ABSTRACT

The matter of Resolution Enhancement has become one of the most important Electronic and Digital processing applications in the last few decades. Super Resolution is one of the techniques used for Resolution Enhancement. Super resolution techniques are used to provide higher resolution of an image without distorting an image. Super resolution can be done using two ways: Single frame and Multi frame. For the former directly an interpolation technique can be applied to get a high resolution image from a low resolution image and for later multiple low resolutions images can be combined to form a high resolution image. Using this techniques resolution of any digital or electronic system can be enhanced. This paper addresses the matter of image super-resolution, which is the strategy by which one or more low-resolution images are processed together to create an image of high quality or set of images with a higher

spatial resolution. Multi-frame image super-resolution refers to the particular case where multiple images of the spot are available.

**Keywords:.** Single Frame, Multi Frame, Direct Addition, Iterative Back projection, Projection onto convex sets (POCS)

## I. INTRODUCTION

Super Resolution: Process of combining multiple low resolution images to form a high resolution image. Using this we can enhance the resolution of any imaging system.

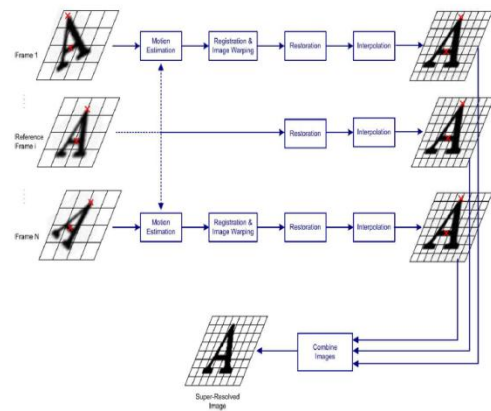


FIG:1 Example of super resolution

## II. FLOW OF SUPER RESOLUTION

- **Image Registration:** Motion estimation is used to determine the relative shifts between

the LR (Low Resolution) images and register the pixels from all available LR images into a common reference grid. Motion compensation and warping of the input LR images onto the reference grid. Motion compensation is used to align all LR frames at some common angle and Warping perform required transformation.

- **Image Fusion:** Fusing of the pixel values from the LR images.
- **Restoration:** Restoration of the LR images in order to reduce the artifacts due to blurring and sensor noise .Restoration is performed to combine all necessary information from specific frames. The filtering is necessary to improve the perceived image quality. Interpolation of the LR images with a some predetermined zoom factor used to obtain the desired HR (High Resolution) image.

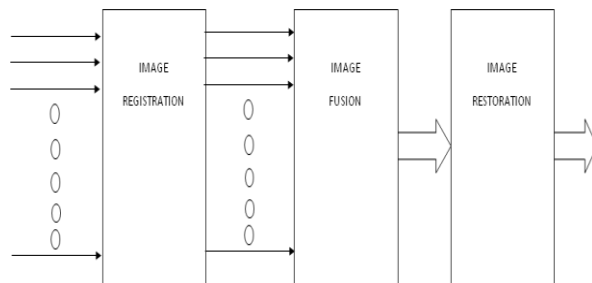


Fig 2:Flow of super resolution

### III. ISSUES RELATED TO SUPER RESOLUTION:

- Aliasing
- Over Sampling
- Diffraction
- Image Registration
- Computation Efficiency
- Performance Limits

### IV. MULTI FRAME SUPER RESOLUTION ENHANCEMENTS:

Multi frame image super resolution is a strategy which takes many low –resolution images of the

same spot obtained under different conditions and processes them all together to combine one or more high quality super resolution images with high spatial resolution with no image blur than any other original image.

Multi-frame image super-resolution refers to the specific case where many images of the spot are available. In general, changes in these low-resolution images caused by camera or spot motion, camera zoom, focus and blur mean that we can recover extra data to allow us to reconstruct an output image at a resolution above the limits of the original camera or other imaging device.

The super resolution strategy works in two stages. The former stage is the image registration stage and the later one is image fusion. After the LR images are registered, they should be fused in a suitable way. The image fusion permits us to merge these details into one high resolution image of the spot. As the outcome image is the high resolution image that is generated from several low resolution images. The name Multi-Frame Resolution Enhancement is used for the Image Fusion step. The two terminologies can be used interchangeably.

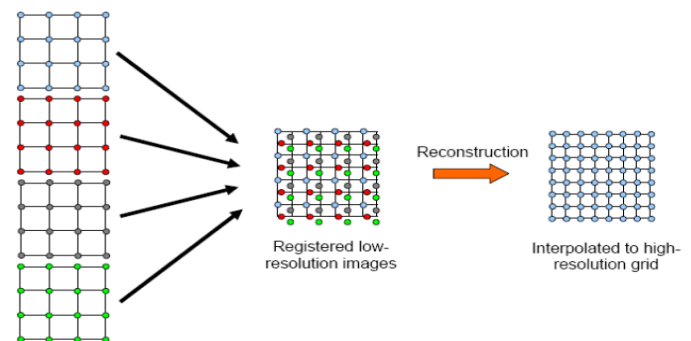


Fig:3 Super resolution process using low resolution frames

### V. Multi Frame Super Resolution Methods:

- Direct addition
- Iterative back projection(IBP)
- Projection onto convex sets (POCS)

## (1) Direct Addition

The ultimate basic method to fuse these images is to get mean or median of the images, after the registration of an input image. These two methods are easy to implement. These methods have limitation of as blurring and degradation of details that are not present in every image. As an advantage these methods can reduce the effect of noise successfully, because of the low pass filtering nature of the mean and median operations. In comparison with the single frame methods<sup>[1]</sup>, these methods are quite unfavorable in consideration of being multi-frame methods. This method becomes considerable because of the noise suppression capability and chance of adding the image restoration methods to algorithm. In addition to these, the two variants of direct addition methods have a very low computational complexity. The motion information is discarded in the direct addition method, after image registration and discarding the information fusion leads to removal of noise effect or enhancement of signal quality but does not improves resolution.

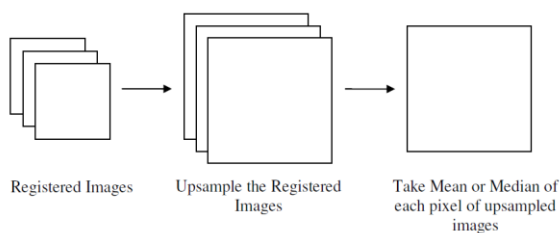


Fig: 4 Pipeline of direct addition with median filter algorithm

First, we have the registered images at hand. These images are up sampled by using single frame super resolution strategy such as bilinear or bicubic interpolation as the first step for achieving resolution enhancement. As we have the up sampled and aligned pictures of the spot, we can add them to form the final image. Then take addition using either mean or median filter. The major limitation of the direct

addition method is the blurring effect as shown by fusion test. Because of the blurring SSIM index and PSNR

values are reduced negatively. Even though blurring is the limitation as noise increases on the image, the cause of this effect suppresses noise. Even if the information is unrecoverable corrupted in one image because of noise, the application of direct addition to the noisy LR images, recovers some information and the quality increases slightly than any of the single frame methods for super resolution.

## (2) Iterative Back Projection

One of the solutions to raise the performance is use the iterative strategy. The Iterative back projection method is one of the multi frame super resolution<sup>[2]</sup>'s restoration method which is common in simple but most powerful simulate and correct approach to restoration. This strategy is easy to understand in application. This strategy needs a prior image to start the process and the strategy uses mean of the registered images. By this way before beginning the iterations, we have the base image to build our outcome.

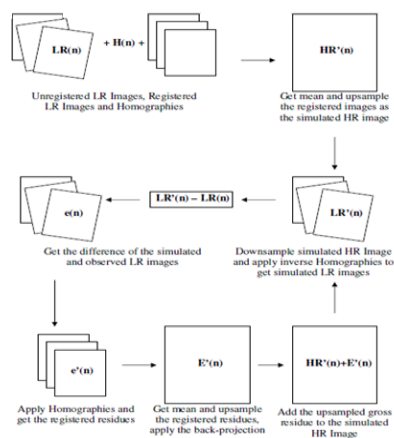


Fig: 5 Pipeline of iterative back projection algorithm

The basic idea in this strategy is to generate a simulation image, generate LR images from the simulation image to compare them with the observed counterparts and using the error between them to generate a better quality simulation. As long as condition is not satisfied the iterations will

continue. The condition may be a threshold value, the point where the quality stop increasing, or simply a predefined number of iterations.

The aim of the IBP<sup>[3]</sup> method is to minimize the error between simulated LR images and the observed LR images iteratively. In addition to this, the noise suppression capability of the IBP method is not very competent as the quality metrics are considered. This is because the priori image suffers from the noise and the noise present on all of the observed LR images exaggerates the error.

### (3) Projection on to Convex Sets (POCS)

Projection on to Convex Sets (POCS) is a set theoretic approach to multi frame super resolution. POCS<sup>[6]</sup> works on the basis of searching constraints on the super resolution image in the form of convex sets of possible values for super resolution pixels such that each set contains every possible super resolution image that leads to each low resolution pixel under the imaging model. Any element in the intersection of all the sets will be entirely consistent with the observed data.

First, the images are registered, and we have the motion compensated coordinates of every pixel. These pixel values must be projected to the HR space and this is done by applying a Gaussian PSF (Point Spread Function) for every pixel. For every image in our set, we have a solution. Then unifying these solutions into the intersection of these sets is the next step. Every pixel value has the prior information and then found value specific to that set. The next thing is to stretch the available estimate to satisfy the solution set we are working on. The pixel value is updated at the level of the threshold to match the projected value as close as possible without disturbing the continuity of the solution. After the prior estimate is stretched to every frame of the input set, first iteration is completed. The solutions are normalized to the intensity space [0,255] and the next simulated HR image is ready.

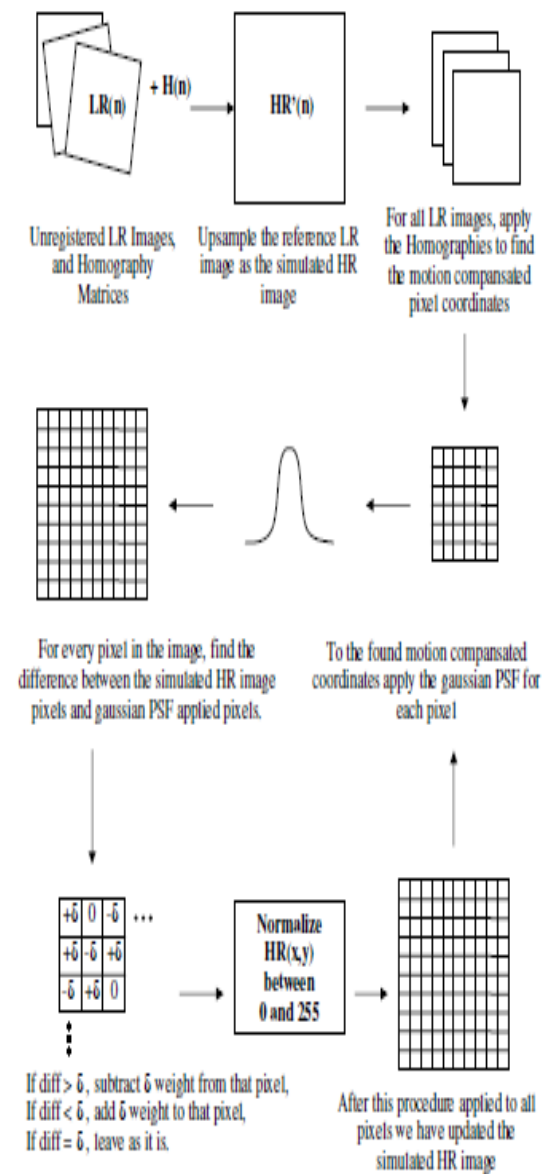


Fig: 6 Pipeline of projection on to convex set algorithm

## VI. Comparison between Multi Frames Super Resolution Methods

| Parameters                        | Noise       | IBP    | POCS   |
|-----------------------------------|-------------|--------|--------|
| SSIM (Structural Similarity)      | 0 noise     | 0.695  | 0.750  |
|                                   | 20 db noise | 0.677  | 0.724  |
| PSNR (Peak Signal to Noise Ratio) | 0 noise     | 12.114 | 12.762 |
|                                   | 20 db noise | 11.938 | 12.364 |

**Table: 1** Comparison of IBP and POCS Methods

## VII. CONCLUSION

Projection onto Convex Sets (POCS) Method has higher value of SSIM and PSNR parameters than IBP and Direct Addition. The Value of SSIM and PSNR must be more for high resolution image, so POCS method will give better result than Direct Addition and IBP. POCS is mostly used in practical applications such as HDTV and Satellite communication and gives better result than other methods as it remove noise and misregistration from original image.

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