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# SUPER-RESOLUTION-A REVIEW

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***ABSTRACT-****Super-resolution is the process of recovering a high-resolution image from multiple low-resolution images of the same scene. An overview of existing super-resolution techniques is provided.Recently single image super resolution is very important research area to generate high-resolution image from given low-resolution image.This paper reviews the development of various approaches on image interpolation and super-resolution theory for image enlargement in multimedia applications.*

***Keywords: Low-Resolution (LR),High-Resolution (HR),Super resolution (SR): –Obtaining a HR image from one or multiple LR images***

## 1. INTRODUCTION

Motivation The phenomenal growth of the Internet, along with the ubiquitous use of digital cameras, scanners and camera phones have made the capture, display, storage and transmission of images, a routine experience. In addition, imaging is extensively used in medicine, law enforcement, Internet gaming and data collected by satellites. Despite rapid improvements in data storage, processing speeds, and digital communication system performance, this proliferation of digital media often outstrips the amount of data storage and transmission capacities. Thus, the compression of such signals has assumed great importance in the use, storage and transmission of digital images. Digital image processing has become a recognized field of science, as well as a broadly accepted methodology, to solve practical problems in many different kinds of human activities. The applications encompass an enormous range, starting perhaps with astronomy, geology, and physics, via medical, biological, and ecological imaging and technological exploitation, up to the initially unexpected use in humane sciences, e.g., archaeology or art history. The results obtained in the area of digital image acquisition, synthesis, processing, and analysis are impressive, though it is often not generally known that digital methods have been applied. Image processing modifies pictures to improve them (enhancement, restoration), extract information (analysis, recognition), and change their structure (composition, image editing). Images can be processed by optical, photographic, and electronic means, but image processing using digital computers is the most common method because digital methods are fast, flexible, and precise. In image processing, I found super resolution technique very interesting. Super-Resolution reconstruction produces one or a set of high-resolution images from a sequence of low-resolution Images. "Super resolution" is a technology that is used to sharpen out-of-focus images or smooth rough edges in images that have been enlarged using a general up-scaling process (such as a bilinear or bicubic process), There by delivering an image with high-quality resolution. In today‘s World more resolution HD camera & HD LED, LCD television are invented & still more work is going on to achieve higher resolution.

By reason of its widespread use, I am motivated to carry the work in this area as a dissertation and as a student of Electronics& Communication Engineering, I was interested in Image resolution & specially in Super Resolution image from the very beginning of my PG course, and now I have a privilege to work in the area of my interest in this PG course. My interest and passion for the subject is the biggest motivation for this topic for dissertation. Image Processing is a technique to enhance raw images received from cameras/sensors placed on satellites, space probes and aircrafts or pictures taken in normal day-to-day life for various applications. Various techniques have been developed in Image Processing during the last four to five decades. Most of the techniques are developed for enhancing images obtained from unmanned space crafts, space probes and military reconnaissance flights. Image Processing systems are becoming popular due to easy availability of powerful personnel computers, large size memory devices, graphics software‘s etc.

1.2 Basic image resolution [4][5]

There are some basic types of Image resolution like pixel resolution, spatial resolution etc. They are used in different ways as its name implies. Pixel resolution used for pixel counting in digital image. While spatial resolution used to measure how closely lines can be resolved in an image. Spectral resolution defines different spectra of color image Where Radiometric resolution used to determine difference of intensity of an image.Applications are Medical imaging (i.e. CAT, MRI, etc.). Satellite imaging Enlarging consumer photographs, Graphics processing equipment ,General devices with built-in display panels, Amusement, game machines, Industrial, Military, civil (e.g. traffic) , Security.

1.3 Need of Super Resolution

The concept of super resolution is based on achieving high resolution image the noisy, blurred and aliased image. The causes of degradation are: Optical blur, Noise and Aliasing effects. Below figure shows the degradation of the low resolution image that used by the recording process.

The acquisition of an image has many details to consider. For example, optical distortions through the optics of the camera, aliasing effect inside the sensor, blurring caused by the unwanted camera shaking and scene motion, additional noise through every part of the pipeline plus the under sampling of the camera make the captured images suffer from spatial resolution loss.[8]

Super-resolution (SR) works effectively when several low resolution images contain slightly different perspectives of the same object. Then total information about the object exceeds information from any single frame. The best case is when an object moves in the video. Motion detection and tracking are then employed to benefit upscaling. If an object doesn't move at all and is identical in all frames, no extra information can be collected. If it moves or transforms too fast then it looks very different in different frames and it's too hard to use information from one frame in reconstructing the other.

1.4 Basic of Super Resolution

Super resolution (SR) is the term used to refer to the image processing done to obtain a high resolution (HR) image from multiple low resolution (LR) images. Super resolution techniques are applied on multiple LR images captured from the same scene in order to increase spatial resolution for a new image of that same scene.That is, LR images are sub sampled (aliased) as well as shifted with sub pixel precision.

If LR images are shifted by integer units, then each image contains the same information, and then there is no new information that can be used to reconstruct a HR image. If the LR images have different sub pixel shifts from each other and if aliasing is present then each image cannot be obtained from the others. In this case, the new information contained in each LR image can be exploited to obtain a HR image.

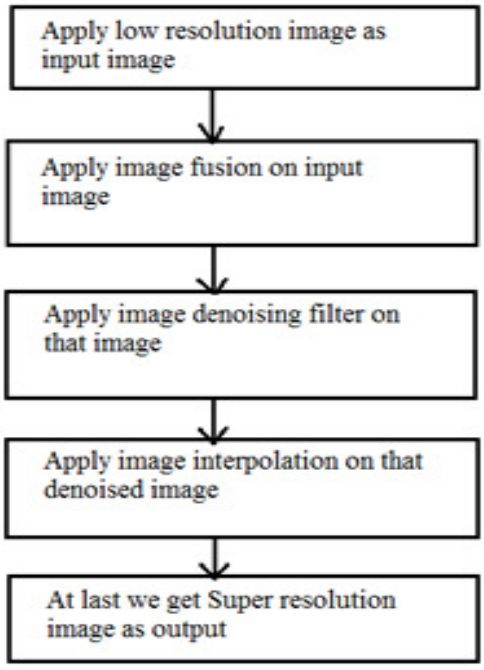
To obtain different looks at the same scene, some relative scene motions most exists from frame to frame from multiple scenes or video sequences. Multiple scenes can be obtained from one camera with several captures or from multiple cameras located indifferent positions. Frame also can be obtained of one scene but from video sequence. If these scene motion are known or can be estimated with sub pixel accuracy and then by combining these LR images, SR image reconstruction is possible.to understand the Super resolution we have to study below model. In below model we will refer yk, where k=1...p as the p low-resolution images and x as the real world high-resolution observation that we try to reach as close as possible at the end of the process. During the observation of the scene, assume that x remains constant.

By this way, all of the p observations are of the same scene. All of the differences between low-resolution images are due to varying imaging conditions of the camera. In addition, the unknown noise is always present on all of the LR images. As a result, we will have p different observations of x. This model of observation can be represented as:

$y_k = D\ B_k\ M_k\ x + n_k$ for $k=1,2\ldots,p$ [1.1]

Where Mk is a transformation matrix, which transforms x in vertical and horizontal shifts and scale variances as well as rotational motions in all 3D coordinate axes. Bk is the blur matrix that can be a result of optical disorder, fast motion, point spread function (PSF) of the sensor etc.

**2 SUPER-RESOLUTION-ALGORITHM**[1][2]




2.1 Image fusion-

Multi frame Image reconstruction image fusion is the integration of the sorted, aligned images

into one common high-resolution grid. The information bits inside the images are fused to form a complete picture of the whole data set. Since every single pixel on the newly formed high-resolution image is a combination of the corresponding low-resolution pixels, the misalignment of these LR images will result in false convergences in data fusion step, which are obviously very disturbing. As a result, only the results of the best image registration method available should be used in the image reconstruction step. If the results of the current image registration algorithms are not precise enough, the known parameters of the synthetic images will be used.

2.2 Image de-noising

Main aim of super resolution is to achieve a sharp looking high resolution image from a set of low resolution images. Two of the most common difficulties in super resolution concept are noise and blur. Actually, image reconstruction is an ill- posed problem in the presence of noise [12], while sensors, lens and atmospheric are the reasons of the blur.

2.3 Image interpolation

There are mainly three type of interpolation as discussed below

Nearest Neighbor Interpolation

Nearest Neighbor Interpolation is the most straightforward solution to the interpolation problem. As it is obvious from the name of the method, the subject of this technique is finding the nearest pixel value to the missing image value at a location then, assigning that nearest pixel values to the missing image value. In this method, the areas of pixels are enlarged by the targeted level of interpolation so the image quality is negatively affected.

Bilinear interpolation

Bilinear Interpolation is a simple but efficient way of enlarging images. The main concern of this method is to fit a bilinear surface through existing data points. The resultant image will be a smoother than the nearest neighbor interpolation. In this method, the available pixels are placed into a HR grid, leaving zeros between them. In both vertical and horizontal directions, empty pixels are filled with the linear function values between the existing pixels. This process is done for the rest of the empty cells including the newly found pixel values into the process. By using this method, every empty pixel is filled with a value affected by the nearest four existing pixels depending on the distance to them.

Bicubic interpolation

Bicubic Interpolation is an advanced version of the bilinear interpolation. Bicubic interpolation uses a 4 by 4 neighborhood to find the missing pixels in the high-resolution grid. Bicubic interpolation uses a polynomial passing through four pixels to make a decision. Therefore, bicubic interpolation creates enlarged images that are smoother and higher quality. When the interpolation is separately applied to rows and columns of an image, we have the bicubic interpolation.

Edge based image interpolation[7]

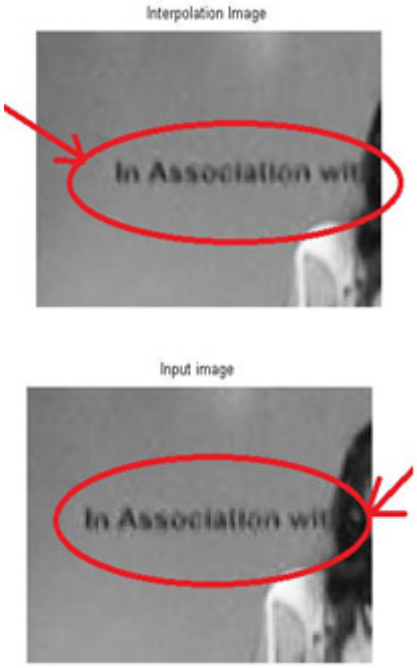
Algorithm Preserving edge structures is a challenge to image interpolation algorithms that Reconstruct a high-resolution image from a low-resolution counterpart. Here a new edge-guided interpolation technique is proposed. For a pixel to be interpolated, two observation sets are defined in two orthogonal directions, and each set produces an estimate of the pixel value. These directional estimates, modeled as different noisy measurements of the missing pixel are fused by the linear minimum mean square- error estimation (LMMSE) technique into a more robust estimate, using the statistics of the two observation sets. Experiments show that this interpolation technique can preserve edge sharpness and reduce ringing artifacts.

**3 RESULT ANALYSIS**

3.1 Input Image


3.2 Output Image


Now see the difference between normal image and super resolution image




## 4. CONCLUSION AND FUTURE WORK

Super resolution mainly used for either image reconstruction based or image recognition based. Here I have made algorithm which is used for image recognition based. Here Super resolution image Algorithm consist mainly image registration, image fusion method, image de-noising filter and image interpolation method. In this thesis three types of images are taken like simple, darken, lighter and in that image de-noising filter is varied. And all other things are constant. After taking all results I conclude that this algorithm is work better in simple image. After analyzing spatial domain filter as well as wavelet filter for my algorithm I conclude that wavelet filter require more computation time compare to spatial domain filter. From the observation I conclude that filter give result as per characteristic of input image so filter is applied as per the image characteristic.in future this algorithm can be implemented for video application.

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