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Analysis of Single Frame Super Resolution Methods

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Abstract: - **The Image Quality can be most often measured in terms of Resolution. The clarity of the Image can be determined by Resolution which means higher the resolution, the image can be more clearer which is most often required in most of the applications. It can be achieved by use of Good Sensors ad optics, but it can be very expensive and also limit way of pixel density within Image. Instead of that we can use image processing methods to obtain High resolution image from low resolution image which can very effective and cheap solution. This Kind of Image Enhancement is called Super Resolution Image Reconstruction.**

This paper focuses on the definition, implementation and analysis on well-known techniques of super resolution. The comparison and analysis are the main concerns to understand the improvements of the super resolution methods over single frame interpolation techniques. In addition, the comparison also gives us an insight to the practical uses of super resolution methods. As a result of the analysis, the critical examination of the techniques and their performance evaluation are achieved.

Super Resolution is particularly useful in forensic imaging, where the extraction of minute details in an image can help to solve a major crime cases.

Super-resolution image restoration has been one of the most important research areas in recent years which goals to obtain a high resolution (HR) image from low resolutions (LR) blurred, noisy, under sampled and displaced image.

***Index Terms*—LR-Low Resolution, HR-High Resolution, Super Resolution, Interpolation**

I. INTRODUCTION

Super Resolution is a technique that is used for improving resolution of a digital and electronic imaging system by converting an image into a high resolution image from a set of low resolution images. Super resolution is a technique which can improve resolution of imaging systems beyond their sensor and optics limit. The high resolutions images are required in much application such as medical field, satellites, videos enhancements and various standard conversions of videos and remote sensing .The Digital images are taken with the help of CCD (Charge Coupled Devices) and CMOS (Complementary metal oxide semi conductor) Sensors. Super resolution can be done using two ways single frame and multi frames. In Single frame super resolution simply zoom the image in such way that it will not be destroyed and it contains all necessary information. Process of combining multiple low resolution frames to form a high resolution image is called multi frames super resolution. Using this we can enhance the resolution of any digital or electronic imaging system.

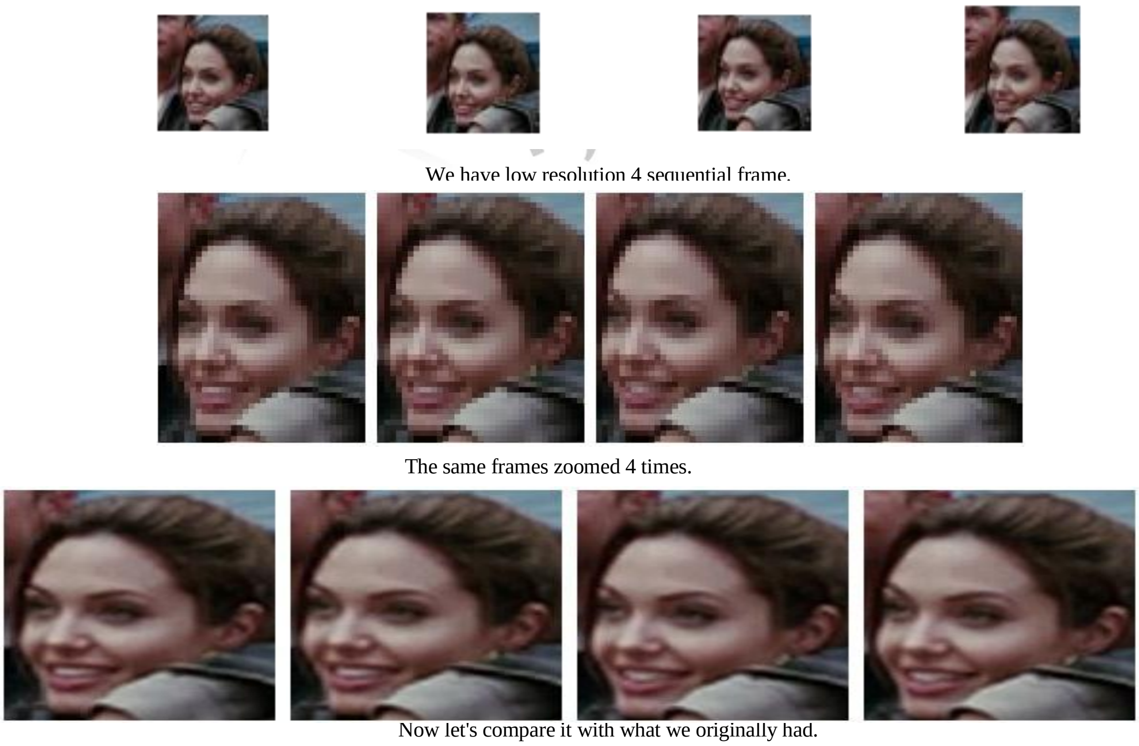

Fig 1. Example of Super Resolution

II. Super Resolution –A Brief Overview

In Major Areas of Electronic Imaging System, Images with High Resolution are desired and often required for later analysis and processing. The need for high image resolution systems rise from two main application areas: it improves the pictorial information for human interpretation; and helping representation for automatic machine perception. A high Resolution means that the pixel density in an image is high and there are more details, and higher the details are, the resolution is high. The resolution of a digital image can be classified in many different ways: pixel resolution, Image resolution, spatial resolution, spectral resolution, temporal resolution, and radiometric resolution. In this paper, we will mainly focus on spatial resolution. Pixels can be defined as small picture elements that construct a digital image. Spatial resolution refers to the pixel density in an image and measures in pixels per unit area.

Be it remote sensing, medical imaging, robot vision, industrial inspection or video enhancement, operating on high resolution images leads to a better analysis in the form of lesser misclassification, better fault detection ,more true positives etc.However acquisition of high resolution images is severely constrained by the drawbacks of the limited density sensors. The images acquired through such sensors suffer from aliasing and blurring. The most convenient solution to increase the spatial resolution is to reduce the pixel size (i.e., to increase the number of pixels per unit area) by the sensor manufacturing techniques. But due to the decrease in pixel size, the light available also decreases causing more shot noise. Which degrades the image quality? Thus, there exists limitations on the pixel size and the optimal size is estimated to be about $40\mu m^2$. Also, the hardware cost of sensor increases with the increase of sensor density or correspondingly image pixel density. Therefore, the hardware limitation on the size of the sensor restricts the spatial resolution of an image that can be captured.

While the image sensors limit the spatial resolution of the image, the image details (high frequency bands) are also limited by the optics, due to lens blurs, lens aberration effects, aperture diffractions and optical blurring due to motion. Constructing imaging chips and optical components to capture very high-resolution images is prohibitively expensive and not practical in most real applications, e.g., widely used surveillance cameras and cell phone built-in cameras. Besides the cost, the resolution of a surveillance camera is also limited in the camera speed and hardware storage. In some other scenarios such as satellite imagery, it is difficult to use high resolution sensors due to physical constraints. Another way to address this problem is to accept the image degradations and use signal processing to post process the captured images, to trade off computational cost with the hardware cost. These techniques are specially referred as Super- Resolution (SR) reconstruction. Another method to improve the resolution is to increase the wafer size which leads to a increase in the capacitance. This approach is not effective since an increase in the capacitance causes a decrease in charge transfer rate. Hence, a most relevant approach is to use image processing methods to construct a high-resolution image from one or more available low-resolution observations.

Super-resolution (SR) is the technique that is used to construct high-resolution (HR) images. Super Resolution can be performed by two ways: Single Frame and Multi frames. In Single frame super resolution image contains only single frame and we can directly apply any interpolation technique on that frame to get high resolution image. Single frame super resolution techniques are easy and faster than multi frames. Interpolation used in single frame super resolution to increase the size of an image with improved image quality. In Multi frames Super Resolution We have multiple low resolution frames that combined to generate single high resolution image. The basic approach behind SR is to combine the non-redundant information contained in multiple low-resolution frames to generate a high-resolution image.

III. Application areas where the super resolution is used

1. Satellite imaging and astronomical imaging:
2. Medical computed tomography:
3. Video Enhancement and restoration:
4. Video standards conversion:
5. Used in enhanced surveillance videos:
6. Remote sensing:

IV. Single Frame Super Resolution Methods:

- **Single frame super resolution enhancement**
    - Nearest neighbor interpolation
    - Bilinear interpolation
    - Bicubic interpolation

(1)Nearest neighbor interpolation

Interpolation is a technique that is used to estimate the value of a unknown pixel by the known value of a neighbor pixels. This algorithm is used for finding the nearest pixel value to the missing image value at a location then assigning that nearest pixel values to the missing image values. This algorithm is the most basic algorithms among all the algorithms which requires minimum processing time among all interpolation algorithms because it considers only one pixel – the one that is closest to the interpolated point. It simply has the capacity of making each pixel bigger. This method determines the grey level value from the nearest pixel to the specified input coordinates, and assigns that value to the output coordinates. This method does not really interpolate values, it just copies existing values. Since it does not alter values, it is preferred if difficult to understand variations in the grey level values need to be retained.

Fig 2. [A] Original [B] Nearest neighbor Interpolated

(2)Bilinear Interpolation

The Final Image will be smoother than the nearest neighbor interpolation. 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. Bilinear interpolation considers the nearest 4 neighbours of known pixel values surrounding the unknown pixel. It then takes a weighted average of these 4 pixels to arrive at its final interpolated value. This results in much smoother looking images than nearest neighbour. The four cell centres from the input raster are closest to the cell centre for the output processing cell will be weighted and based on distance and then averaged.

Fig 3. [A] Original [B] Bilinear Interpolated

(3)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. Therefore, bicubic interpolation creates enlarged images that are smoother and higher quality. Bicubic goes one step beyond bilinear by considering the closest 4x4 neighbourhood of known pixels — for a total of 16 pixels. Since these are at various distances from the unknown pixel, closer pixels are given a higher weighting in the calculation. Bicubic produces noticeably sharper images than the previous two methods, and is perhaps the ideal combination of processing time and output quality. For this reason it is a standard in many image editing programs (including Adobe Photoshop), printer drivers and in-camera interpolation.

Fig 4. [A] Original [B] Bicubic Interpolated

V. Comparision between Interpolation Methods

Sr. No.	Nearest Neighbor Interpolation	Bilinear Interpolation	Bicubic Interpolation
(1)	For nearest neighbor interpolation, the block uses the value of nearby translated pixel values for the output pixel values.	For bilinear interpolation, the block uses the weighted average of two translated pixel values for each output pixel value.	For bicubic interpolation, the block uses the weighted average of four translated pixel values for each output pixel value.
(2)	It is the most basic interpolation technique and requires less processing time	This technique performs interpolation in both directions, horizontal and vertical. This technique is give better result than nearest neighbor interpolation and take less computation time compare to bicubic interpolation.	Bicubic gives sharper images than previous two methods. This technique gives better result but take more computational time. When time is not a constraint then this technique give the best result among all the all techniques.
(3)	This method is most suitable for reprojecting a raster object without a change in cell size when preserving the original cell values for later quantitative analysis is important.	it is only used as an intermediate transformation in some analysis tasks, mainly due to the fact that it does not generate undershoot (ringing) artifacts.	It is a standard in many image editing programs including Adobe Photoshop, printer drivers and in-camera interpolation.
(4)	Nearest neighbor doesn't have subpixel accuracy and generates strong discontinuities, especially when arbitrary rotations and scale changes are involved.	The main drawbacks of bilinear interpolation are poor preservation of image detail and generation of strong aliasing artifacts for rotated images.	Due to the negative lobes of the bicubic spline interpolation function, this algorithm generates undershoot artifacts(ringing).

TABLE I. Comparison of different Single Frame Super Resolution Methods

VI. CONCLUSION

In Bicubic Interpolation Technique we take 4 by 4 total 16 pixels so bicubic interpolation technique will give more sharper image. Output of Bicubic interpolation will not contain any blocking effect. Bicubic interpolation will give more better result than nearest and bilinear interpolation so it used in real life applications such as Adobe photoshop and camera.

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REFERENCES

[1] Research on fast super-resolution image reconstruction base on image sequence Gaohua Liao; Sch. of Mech. Eng., Nanchang Inst. of Technol.; Nanchang, China Quanguo Lu;Xunxiang Li.

[2] Simon Baker and Takeo Kanade, “Limits on Super-Resolution and How to Break Them”, The Robotics Institute Carnegie, Mellon University Pittsburgh, PA 15213

[3] Emre Ugur, “A Learning Based Method for Super-Resolution of Low Resolution Images”.

[4] Daniel Glasner, Shai Bagon and Michal Irani, Dept. of Computer Science and Applied Mathematics, The Weizmann Institute of Science, Rehovot 76100, Israel “Super-Resolution from a Single Image”.