Study of Commonly Used Image Interpolation Techniques for Single Frame Super Resolution Methods

[1]Koustav Guha, [2]Soumyajit Chakraborty

[1,2]Final Year Student, Department of Computer Science, University of Engineering and Management, Kolkata.

Abstract- Image quality is defined with respect to the term known as resolution. Basically, resolution illustrates the clarity of an image. Feasible sensors can be implemented for achieving higher quality of images but it is not exorbitant. Instead of focusing on various image processing ways, our focus should be on preparing higher resolution images and it would also be affordable. The term which is used for this process, is known as Super Resolution Image Reconstruction which is used for improvement of image quality.

The whole paper focuses of generation and analysis of multiple methods of super resolution. In the current days, satellite image processing, medical image processing and many other departments use these processes for obtaining excellent resolution images from. The editing applications also use these processes for generating high resolution images or hazy images.

In recent years enhancing the quality of image using Super Resolution methods have got very famous and further researches are going on for rendering more efficient pictures.

Keywords- Interpolation, High resolution, Low resolution, Super Resolution, Bicubic**.**

INTRODUCTION

In our day to day lives, we encounter different types of images. The images are upgraded by the hard work and emphasis of graphics engineers, machine learning engineers. While coming to screen display, at the first time CRT screen was used for displaying pictures and videos, then with the revolution of LCDs, LEDs and so on, the quality of pictures increased. In today's world, image has an important aspect in several aspects of our life. From presentations to videos, from video call to meeting sessions etc. Now as images plays a substantial role in the current days. Hence, we can say while taking of cropping pictures, we need to achieve its best quality for the clarity of understanding. Well, it would be more suitable to estimate the quality of a magnified image through subjective methods.

At the end we will be dividing the image into several segments and then by doing magnification on every segment, we will be evaluating the average quality and hence check it for whether the image is having a good clarity or not.

RELATED WORKS

The improvised versions of images are being demanded highly now a days by the people. Most importantly, an image with high resolution helps people to do a perfect study, identify and even research as well. Images also has a major role in our day to day lives, for example, a meeting conference. Let's say for instance, for attending an online webinar or confidential conference meeting, there's an eye scan done for recognizing the participants of the meeting. So, the more the clarity of the image, more would be the capability to recognize. Like we say, we used Adobe scanner for scanning the documents. After scanning the picture of document looks crystal clear and it helps the other person to read the file. If we consider high resolution, that density of pixels of the image should be high. Classification of images can be done in several ways like, pixel resolution, image resolution, spectral resolution, video enhancement etc.

BACKGROUND

Super Resolution:

The task of restoring images having high resolution from low resolution observation is known as Super Resolution. Based on the number of inputs of Low Resolution images, the Super Resolution images can be classified into Multiple Image Super Resolution and Single Image Super Resolution, the latter is more popular because of its efficiency. Since an image with High Resolution with high perceptual quality is having more precise details, it is used in lots of areas, such including satellite imaging, medical imaging and security imaging.

Also, sensors can be used for generating High Resolution images from images that are of poor quality, but its not practical in most of the real world applications and its also very expensive. In addition to that the resolution of the sensor in camera is also limit its size and storage. For instance, in satellites it is very challenging in using the sensors having high resolution due to its physical constraints. So, most effective approach is by using image processing techniques for construction of images with High resolution from images that are of Low Resolution.

Interpolation methods like bilinear, bicubic are used but the latter is widely used as its speedy and straightforward.

Applications:

- Satellite image processing
- Medical Image Processing
- Astrological Studies
- Multimedia Industry and Video Enhancement
- Microscopy Image Processing

METHODOLOGY

Single Frame Super Resolution Methods:

- Nearest neighbour interpolation
- Bilinear Interpolation
- Bicubic Interpolation
- Cubic B-Spline interpolation

Lots of possible interpolation methods that are available while using geometric transforms.
These methods include:

Nearest neighbour interpolation

Nearest neighbour interpolation is the elementary approach for interpolation. In this method, by using the value of known pixel, the unknown pixel's value is estimated. Instead of calculating the average value with some other values or criteria, this method just copies the existing value due to which it requires the minimum processing time among all other techniques but the generated image may contain few edges that are jagged. Since it not based upon any kind of theory so there is not need to check whether any assumptions are satisfied or not, secondly doing any computations is not required, essentially it can be done with a map of the data locations and the interpolation locations and a scheme to find the "nearest neighbour" for any interpolation location.

1	2	3
4	5	6
7	8	9

(A)

1	1	2	2	3	3
1	1	2	2	3	3
4	4	5	5	6	6
4	4	5	5	6	6
7	7	8	8	9	9
7	7	8	8	9	9

(B)

Suppose 'A' is the original image and 'B' is the image generated after interpolation, we can see that here 'A' which is a 3 by 3 image(matrix) is interpolated to a 6 by 6 image which is 'B'. So, it is observed that so new values are added just the values are copied from the previous image.

Bilinear Interpolation

Just as Linear interpolation surveys the 2 nearest pixels and takes its average for arriving to its interpolated value, the one which is final, in the same way Bilinear interpolation means applying linear interpolation into two directions. So, it considers the 2 by 2 closest neighbourhood of the known pixel values that are neighbouring the unknown pixel. After that using the weighted average values of these 4 pixels it arrives at the result of its final interpolated value. As a result, it forms images that are much smoother than that of nearest neighbour.

```
array([[10, 10, 10, 20, 20, 20],
       [10, 10, 10, 20, 20, 20],
       [10, 10, 10, 20, 20, 20],
       [30, 30, 30, 40, 40, 40],
       [30, 30, 30, 40, 40, 40],
       [30, 30, 30, 40, 40, 40]], dtype=uint8)
```

Fig. 1

In Fig. 1, we can see that Bi-linear uses 4 nearest neighbours to determine the output

Bicubic Interpolation

As it has been seen that in bilinear interpolation 2x2 neighbourhood are considered but here, in case of bicubic interpolation, considering the 4 by 4 closest neighbourhood of the pixels are used for finding out the missing pixels. So, basically it is an improvised version of bilinear interpolation. Images generated by bicubic are much sharper than bilinear and nearest neighbour, so it is perhaps the best combination of output quality and processing time. That's why it is a commonly used in many printer drivers, image editing programs and in-camera interpolation.

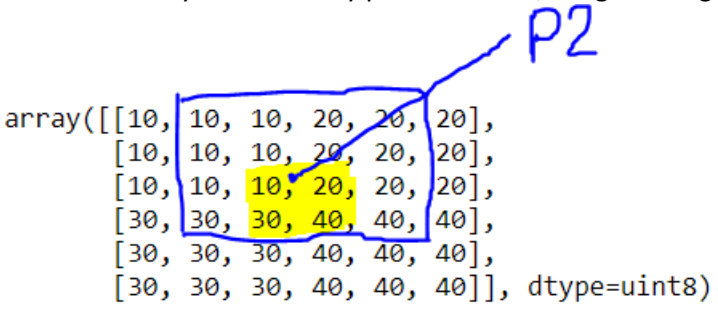

Fig. 2

In Fig. 2, we can see that Bi-cubic uses 16 (4×4 neighbourhood) for determining the output

Here 'E' is the original matrix and 'F' is the final matrix that is generated when the bicubic interpolation method is applied. As this method produces much sharper results than the above mentioned two methods, so it's widely used in most image processing techniques.

Cubic B-Spline Interpolation

In order to have better quality image, lots of new algorithms are proposed. They are using more complex improvised interpolation methods such as Mitchell interpolation and B spline algorithm. Their target is to male curve of interpolation smoother and making the edges of the image more accurate.

RESULTS

I.

II.

III.

IV.

V.

Here we can see that **I.** shows the original image. **II.** shows the image generated by nearest neighbor interpolation. **III.** shows the image generated by bilinear interpolation **III.** shows the image generated by bicubic interpolation and **IV.** Shows the image formed by cubic B-spline algorithm. Here, it's observed that as we move from left to right, the quality of image generated improves.

At the end the image scoring average is used to find the subjective image quality.

The subjective evaluations having different interpolation methods are shown in Table. 1.

Sr NO.	Interpolation Type	Image Contour	Overall Evaluation	Processing Time (seconds)
1	Nearest Neighbour	Not clear	Worst	1
2	Bilinear	not clear, saw-edged phenomenon	Poor	1.5
3	Bicubic	Saw-edged phenomenon having improved edges	Better	2.5
4	B-Spline	becomes clear, saw edged phenomenon disappeared	Good	4

TABLE I. Contrast table of subjective evaluation having different interpolation methods

CONCLUSIONS

Nearest neighbour algorithm is the fastest and most simple algorithm but the quality of image generated is not that much clear.

Bilinear algorithm is better than nearest neighbour but still the image contour is not clear and has serrate phenomenon.

Bicubic algorithm has better than all of them so because of this reason its mainly used in editing and image processing techniques nowadays.

Image generated by B-spline is smooth but when the factor of amplification is more, it causes the false artificial traces and edge fuzzy.

So, it can be observed that though B-spline generates smoother images still the overall image quality is better in case of bicubic because when the factor of amplification is more, it causes false artificial traces and fuzzy edges. So, bicubic is most commonly used method which is used in recent times.

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