

## Comparison Among Some Image Zooming Methods

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### Abstract:

The research interested in digital image zooming from (128x128) to (256x256) using three of the zooming methods namely; Bilinear Interpolation, Nearest Neighbour Interpolation, and Linear Interpolation methods, then image difference measures (PSNR, MSE) computed for each output image from the three methods. The results show that Nearest Neighbour Interpolation is the best method. The research programmed using matlab language Ver. 7.

### مقارنة بين طرق تكبير الصور الرقمية

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### ملخص البحث:

اهتم البحث بتكبير الصور الرقمية من حجم (128 x 128) إلى حجم (255x255) باستخدام ثلاثة من طرائق تكبير الصور الرقمية وهي: ( Bilinear Interpolation, Nearest Neighbor Interpolation, and Linear Interpolation ) وبعد حساب مقاييس أداء الاسترجاع للصور الناتجة من كل طريقة من الطرائق أعلاه وهي (PSNR , MSE) تبين ان طريقة ( Nearest Neighbour Interpolation ) هي أفضل الطرائق المستخدمة. تم برمجة البحث باستخدام لغة Matlab الإصدار السابع.

### Introduction:

Due to the development of modern information technology, image processing is becoming more and more important in our life. Digital zooming is encountered in many real applications such as electronic publishing ,image data base ,digital camera ,visible wireless telephone ,medical imaging and so on .In order to have better and fine images for users ,images often need to be

zoomed in and out or reproduced to higher resolution from lower resolution [2].

The problem of producing an enlarged picture from a given digital image is a relevant research issue. This problem arises frequently whenever a user wishes to zoom in to get a better view of a given picture. As known, there are several issues to take into consideration about zooming: unavoidable smoothing effects, reconstruction of high frequency details without the introduction of artifacts and computational efficiency. Several good zooming techniques are nowadays well known[6].

Image zooming is a direct application of image interpolation procedures. Image interpolation is the process of determining the unknown values of an image at position lying between some known values ,called samples. Interpolation methods are required in various tasks in image processing and computer vision such as image generation ,compression ,and zooming [3]. Image interpolation is a general research method for image zooming. Many image interpolation techniques of different tradeoffs between computational complexity and re-production quality were developed. Popular methods, as commonly used in image/video software and hardware products, are nearest-neighbor interpolation, bilinear interpolation[5], cubic convolution interpolation [6] and cubicspline interpolation [7].

Those methods are based on a simple polynomial model, and work as low-pass filter which restrained the high-Frequency components of the digital image. The main advantage of these methods is their relatively low complexity.[2]

A generic zooming algorithm tasks as input RGB pictures and provides as output picture of greater size preserving as much as possible the information content of the original image for a large class of zooming techniques this is achieved by interpolation : replication ,bilinear and bicubic are the most popular choices and they are implemented in commercial digital image processing software[4].

The steps of our work shown in figure (1):

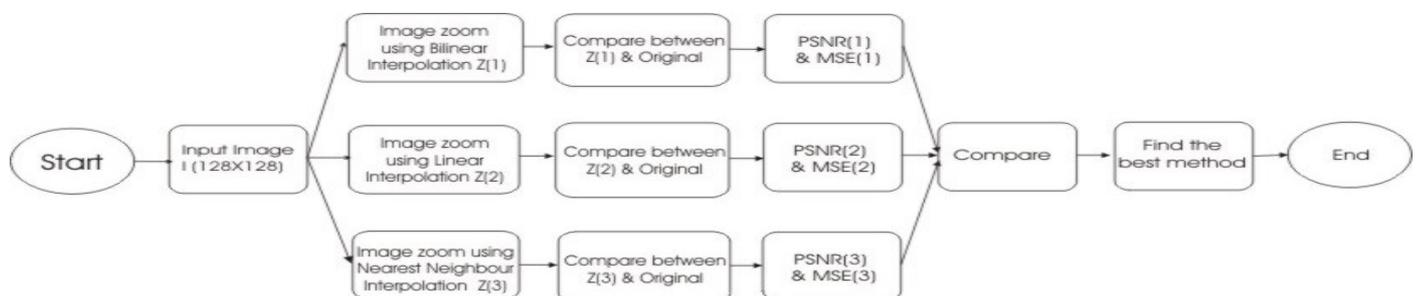


Figure (1): The block diagram of the work

The paper includes in section one the Introduction, the proposed approach in section two, and the Image difference measures are in section three, section four includes experiments, section five and six contains conclusion and references.

## 2- Proposed Techniques:

### 2-1-Bilinear Interpolation( Row and column expansion)

#### method:

The easiest way to do this is to find the average value between two pixels and use that as the pixel value between those two pixels. This can be done for the rows first, for example [1] :

Original image

```
8 4 8
4 8 4
8 2 8
```

Image with Row expansion

```
8 6 4 6 8
4 6 8 6 4
8 5 2 5 8
```

The first two pixels in the first row are averaged  $(8+4)/2 = 6$  , and this number is inserted between those two pixels. This done for every pixel pair in each row, next take the result(the image after expanding its rows) and expand the columns in the same way. We compute the average between each two pixel in the same column such as  $(6+5) / 2 = 5.5$  , as follows[1]:

Image with Row and column Expansion

```
8 6 4 6 8
6 6 6 6 6
4 6 8 6 4
6 5.5 5 5.5 6
8 5 2 5 8
```

This method allows to enlarge an  $N*N$  sized image to size of  $(2n-1)*(2n-1)$  and can be repeated as desired [5].

### 2-2- Linear interpolation Method(Convolution method ):

With this method of image enlargement ,a two – step process is required[1]:

1. Extend the image by adding rows and column of zeros between the existing rows & column.
2. Perform the convolution .

Original Image Array

3 5 7  
2 7 6  
3 4 9

image Extended with zeros

0 0 0 0 0 0 0  
0 3 0 5 0 7 0  
0 0 0 0 0 0 0  
0 2 0 7 0 6 0  
0 0 0 0 0 0 0  
0 3 0 4 0 9 0  
0 0 0 0 0 0 0

Next , the convolution mask were used, with is slid across the extended image ,and perform a simple arithmetic operation at each pixel location[1] .

Convolution Mask

1/4 1/2 1/4  
1/2 1 1/2  
1/4 1/2 1/4

The convolution process requires us to overlay the mask on the image ,multiply the coincident values and sum all these results. This is equivalent to finding the vector inner product of the mask with underlying sub image, Multiplying coincident terms, and summing the resulting products[8].

For example, if we put the mask over the upper-left corner of the image, we obtain (from right to left, and top to bottom):

$$1/4(0) + 1/2(0) + 1/4(0) + 1/2(0) + 1(3) + 1/2(0) + 1/4(0) + 1/2(0) + 1/4(0) = 3$$

Note that the existing image values do not change. The next step is to slide the mask over by one pixel and repeat the process, as follows:

$$1/4(0) + 1/2(0) + 1/4(0) + 1/2(3) + 1(0) + 1/2(5) + 1/4(0) + 1/2(0) + 1/4(0) = 4$$

Note this is the average of the two existing neighbors. This process continues until we get to the end of the row, each time placing the result of the operation in the location corresponding to the center of the mask.[1]

When the end of the row is reached, the mask is moved down one row, and the process is repeated row by row. This procedure has been performed on the entire image, the process of sliding, multiplying and summing is called convolution[8].

### The convolution process :

a. Overlay the convolution mask in the upper-left corner of the image. Multiply coincident terms, sum, and put the result into the image buffer at the location that corresponds to the masks current center[8].

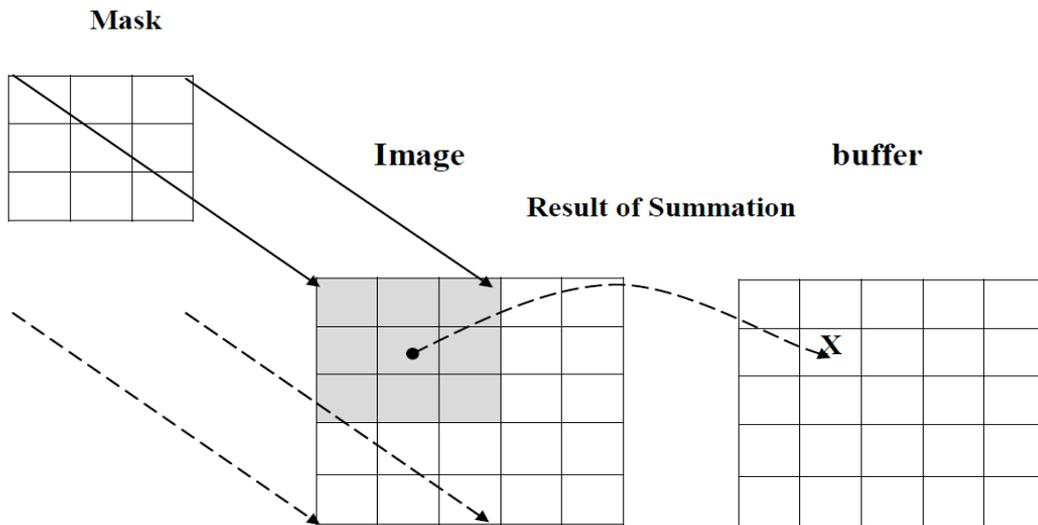


Figure (2) : Illustrate the step one of convolution process

b. Move the mask one pixel to the right , multiply coincident terms sum , and place the new results into the buffer at the location that corresponds to the new center location of the convolution mask, continue to the end of the row[8].

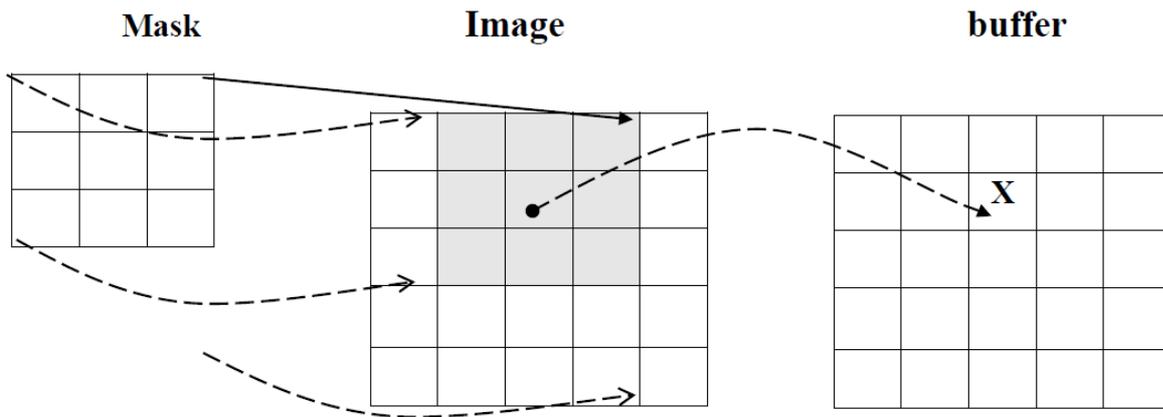


Figure (3): Illustrate the step two of convolution process

c. Move the mask down on row and repeat the process until the mask is convolved with the entire image [8].

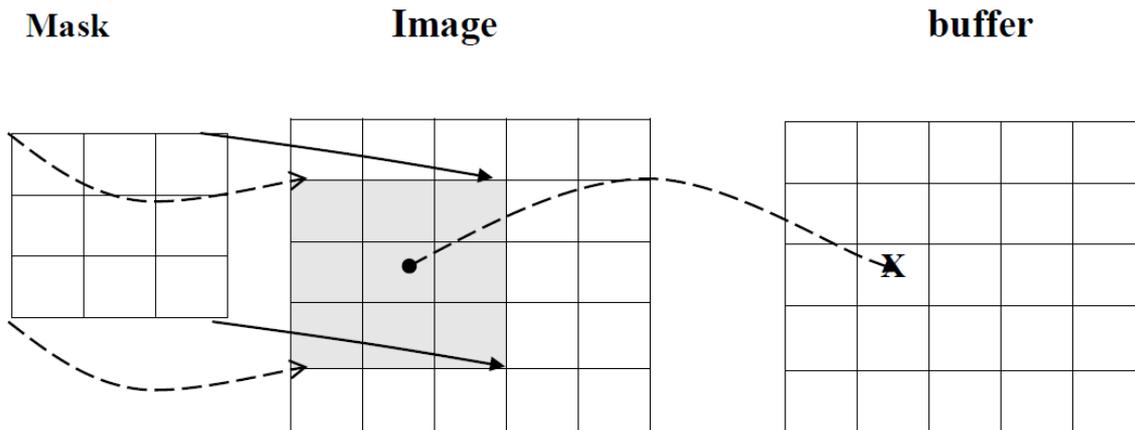


Figure (4) :illustrate step three of convolution process

**2-3-Nearest Neighbour interpolation method (Replication method):**

Nearest Neighbour interpolation is applicable when we want to increase the size of an image, we can duplicate each column. This doubles the image size in the horizontal direction. Then duplicate each row of the enlarged image to double the size in the vertical direction. The same procedure is used to enlarge the image by any integer number of times (triple,quadruple,and so on)[6].

In this method the pixel value was repeated. so in order to zoom a 50 \* 50 section up to 200 \* 200 each pixel should repeated four times in each direction [7].

For example suppose that we have this sub image[9]:

**Original sub image**

40 20 10  
70 50 30  
90 80 10

**Zoomed image in row and column direction**

40 40 20 20 10 10  
 40 40 20 20 10 10  
 70 70 50 50 30 30  
 70 70 50 50 30 30  
 90 90 80 80 10 10  
 90 90 80 80 10 10

**3. Image difference measures:****3-1-MSE: Mean Squared Error [6]**

$$MSE = \frac{1}{NX \cdot NY} \sum_{y=1}^{NY} \sum_{x=1}^{NX} (F(X,Y) - G(X,Y))^2$$

Where: F and G are Images

**3-2-PSNR: Peak-Signal-Noise-Ration [6]**

$$PSNR = 10 \log_{10} \frac{255^2}{MSE}$$

MSE: the value of Mean squared error .

**4. Experiments:**

To evaluate the performance of our proposed methods, six images were selected as a source. The observation for zoomed image quality is concerned with two factors. One factor is the visual observation in which the human eyes observe the quality of zoomed image. Another factor is through PSNR to observe the quality of zoomed images. In order to measure the PSNR value, the original image is reduced to small one by the image processing software (e.g. Photoshop). Then use zooming method to zoom back to its original size. Thus, the computation of PSNR values between the zoomed and original images can be made.

**Table (1): Results of zooming by using Bilinear interpolation Method**

Images name	Original images (128 x 128)	Zoomed images (255x255) (Bilinear interpolation method)
parrot		
pencils		
medicines		
coins		
peppers		
baby		

In Table (1), we illustrate the original images (they are six) with size (128 x 128 ) and the zoomed images by using bilinear interpolation method to size (256 x 256).

**Table (2): Results of zooming by using linear interpolation Method**

images	Original images (128 x 128)	Zoomed images (255x255) (linear interpolation Method)
parrot		
pencils		
medicines		
coins		
Peppers		



In Table (2) , we illustrate the original images (they are six) with size (128 x 128 ) and the zoomed images by using convolution method to size (256 x 256).

**Table (3): Results of zooming by using nearest neighbour interpolation Method**

Images	Original images (128 x 128)	Zoomed images (255x255) (Nearest interpolation method )
parrot		
pencils		
medicines		
coins		

Peppers		
baby		

In Table (3), we illustrate the original images (they are six) with size (128 x 128 ) and the zoomed images by using nearest neighbor interpolation to size (256 x 256).

To compare among these three methods we compute image difference measures like (PSNR) and (MSE) for each zoomed image (output image), as shown in Table (4):

**Table (4): illustrate results of image difference measures (PSNR & MSE).**

Image	Method	PSNR	MSE
Parrot	Repeated	27.2402	122.7622
	Rows & Columns	15.0901	2.0141e+003
	Zeros	7.7103	1.1017e+004
Pencils	Repeated	28.7313	87.0866
	Rows & Columns	14.7598	2.1732e+003
	Zeros	6.9079	1.3252e+004
Medicines	Repeated	29.2928	76.5246
	Rows & Columns	13.3961	2.9749e+003
	Zeros	5.9484	1.6529e+004
Coins	Repeated	23.9391	262.5248
	Rows & Columns	11.4480	4.6589e+003
	Zeros	4.8939	2.1071e+004
Peppers	Repeated	31.6934	44.0293
	Rows & Columns	19.1341	793.7250
	Zeros	10.2934	6.0777e+003
baby	Repeated	26.2927	152.6884
	Rows & Columns	17.4039	1.1822e+003
	Zeros	7.2821	1.2158e+004

## 5- Conclusion:

There are a number of techniques that can be used to enlarge an image. The three most common are presented in this paper. Nearest neighbour interpolation (Replication) is the most efficient in terms of computation time. Bilinear interpolation (Row and Column Expansion) requires 3 to 4 times the computation time of nearest neighbour interpolation. Bilinear interpolation generates an image of smoother appearance than nearest neighbour interpolation.

Linear interpolation (convolution) method takes computation times more than two approaches above (Nearest neighbour interpolation) and (bilinear interpolation).

All the results based on PSNR & MSE indicate that Replication method is efficient for image zooming and has good subjective quality for the coloured image.

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