G301

Digital Image Magnification In Two Phase Using Low Pass Filter and Bilinear Interpolation

Cahyo Darujati[1)], Syamsul Anam[2)]
Faculty of Computer Science
Narotama University, UNNAR
Surabaya, Indonesia
cahyo.darujati[1)], syamsul.anam[2)] @narotama.ac.id

Hasan Dwi Cahyono[3)], Agustinus Bimo Gumelar[4)]
Faculty of Computer Science
Narotama University, UNNAR
Surabaya, Indonesia
hasan.dwi[3)],bimogumelar[4)] @narotama.ac.id

Abstract*—Nowadays in digital image processing techniques, magnification process is aims to enlarge the size of the image.** ***Several previous studies, using this techniques to enlarge the whole object in digital images, sometimes required magnification at a particular object. This research aims to create an application of digital image magnification with two phase. The magnification process is created by two processes, first process is cropping the digital image, and the second process is enlarged filtration process with bilinear interpolation method. The output is a average value of both processes. The final results show a magnification using this method produces values Mean Square Error (MSE) is smaller and the PSNR value 73 % is greater than non-combined method.

Keywords—Digital Image Maginification, Bilinear Interpolation, Low Pass Filter

I. INTRODUCTION

Recently researches on image magnification is almost basic of image processing operations and has many applications in a various area. Image magnification has been attracting a great deal of attention for long, and many approaches have been proposed to date.Nevertheless,bicubic interpolation is still the standard approach since it can be easily computed and does not require apriori knowledge nor a complicated model [10]. Inspite of such conveniencetheimages enlarged bicubically are blurry, in particular for large magnification factors.Digital zooming method generally uses the nearest neighbor interpolation method, which is simpler and faster than other methods. But it has drawbacks such as blocking phenomenon when an image is enlarged, alsoto improve the drawbacks, there exist bilinear interpolation method and the cubic convolution interpolation which commercially used in the software market [5]. The bilinear method uses the average of 4 neighborhood pixels. It can solve the blocking phenomenon but brings loss of the image like blurring phenomenon when the image is enlarged. Cubic convolution interpolation improved the loss of image like the nearest neighbor interpolation and bilinear interpolation. But it is slow as it uses the offset of 16 neighborhood pixels [1,6,8]. A number of methodsfor magnifyingimageshave been proposed to solve such problems. However, proposed methods on magnifying images have the disadvantage that either the sharpness of the edges cannot be preserved or that some highly visible artifacts are produced in the magnified image. Although previous methods show a high performance in special environment, there are still the basic problems left behind. Digital imagery to convey information about the position, size and the inter-relationships between objects. Digital image depicting the spatial information that could recognize. Approximately 75% of the information received by humans is in the form of images [2]. Perceiving human faces is one of the most important functionsforhuman computerinteraction [9].Facial element from human face has been become an object of fascination. It because facial biometrics have an objects element of interest. Objects element of interest include human and non-human bodies, facial expressions, camera positions, and other elements in a scene. In most instances, a live subject, most likely human, is used as the source of data which is transformed into another form. Furthermore to understanding this cognition, it is also increasing interest in analyzing shapes of facial surfaces. Asfacesareoneofthemostexpressivepartsofhuman beings,facedetectionandrecognition areveryimportant topicsformanyapplications [9]. Magnification image is closely associated with high storage size and the media is a plural subject valueable in image processing. Magnification image means changing the number of pixels per image pixel display is only in appearance. Zoom = 1, meaning there is one screen pixel per pixel in the image. Zoom = 2, meaning there are 2 screen pixels per image pixel in both the x and y coordinates. This enlargement is measured by the number of digits calculated numbers or numbers greater than one, which is called magnification. When this number is less than a reference to the reduction in the size of the image, or the so-called minification.

Magnification image is one of the basic image processing operations. Magnification is also a process of enlarging something only in appearance, not in physical size. In general, the enlargement is divided into two, namely: (i). Linear or transverse magnification - For real images, such as images projected on the screen, size means a linear dimension (eg, in millimeters or inches). (ii). Magnification angle - the placement of objects closer to the eye of the eye usually can focus. Standard methods such as the JPEG standard that can be accepted between lossy methods, but still have good quality results. Magnification related to the size of the image to be able to see more detail, increase resolution, using optics, printing techniques, or digital processing [3,4]. As an example application is image interpolation on regular display satellite imagery to do more sophisticated magnification of the original image. In some literature mentions, most of the image interpolation technique has been developed by interpolating pixels based on the characteristics of the local features such as edge information, the nearest neighbor criteria, [3] proposed a new mathematical technique for image interpolation. This technique is modified by non-local denoising algorithm to perform upsampling and remove noise simultaneously. [11] conducted experiments to enlarge the image by 200% with a PSNR of 36.31. The study was also carried out by [11] section blank pixels with Edge-Adaptive methods in digital image magnification, and conduct experiments on image gray color and RGB color images.

The motivation of this research is to implement an algorithm for digital image magnification that does not require a large amount of user input. A realistic image of the real world will be free of artifacts such as blurring, shadowing and jaggies. The image should include smooth contours and rapid transition edge.

II. LITERATURE

A. Digital Image Magnification

Digital image processing enables the reversible, virtually noise-free modification of an image in the form of a matrix of integers instead of the classical darkroom manipulations or filtration of time-dependent voltages necessary for analog images and video signals. Even though many image processing algorithms are extremely powerful, the average user often applies operations to digital images without concern for the underlying principles behind these manipulations. The images that result from careless manipulation are often severely degraded or otherwise compromised with respect to those that could be produced if the power and versatility of the digital processing software were correctly utilized. Digital image processing makes use of digital computers to process an image. In digital image processing we require two types of information; either the whole input image or some interested information from the user point of view like radius, objects etc. There are various advantages of using digital image processing like preservation of original data accuracy, flexibility and repeatability. Digital image processing includes scaling of image as an important area. Scaling operation plays an important in resizing digital images. Scaling is used for shrinking or zooming of an image. Interpolation is used to find the value of unknown pixels with the help of known pixel values. There is wide variety of image interpolation methods available. Basicly, zooming implies enlargement or magnification of an image for a better view of it. Image zooming known as oversampling.. Zooming is a process of creating new location of pixels and to assign values to new locations. A zooming algorithm takes an image as input and generates a picture of larger size. A zooming algorithm is characterizing good if the required information is acquired after zooming process [12]. PSNR are measures to evaluate the quality of zoomed image. PSNR (peak signal to noise ratio) is a quantitative measure, which is used to compare the quality of an original and zoomed image.

B. Digital ImagesZoomingand Repositioning

Zooming on an image are accomplished by making multiple copies of the pixels of the selected region. It produces an increase in its displayed size, with a corresponding increase in "pixel" size. Although those process does not increase the information content of the region of interest, it can be helpful in the visualization of small structures or for the examination of individual pixel brightness values. There are several useful algorithms available for performing a zoom operation on a digital image. The simplest and most accurate algorithm, known as the **discrete replicating zoom**, performs by displaying multiple copies of each pixel in the area of interest [13]. This algorithm operates in discrete steps, it can produce zoomed images at integral zoom factors of 2x, 4x, and higher. Individual pixels become readily apparent at 4x or higher zoom factors, depending upon the spatial resolution of the image.Fractionally zoomed images can also be obtained by varying the number of copies made of each pixel in the area of interest. The most commonly employed algorithm is known as the **fractional replicating zoom**, which works by copying pixels from the source image into the zoomed image based upon an inexact spatial correspondence between the two. In effect, pixel addresses in the source image are calculated fractionally, based on the ratio between the zoomed image dimensions to the source image dimensions. Because the calculated pixel address is fractional, a decision must be made as to what to do with the fractional part of the address. There are several approaches to this problem. One of the most common, **interpolation**, is based on an estimation of the value between two or more known values, and there are a wide variety of published algorithms to address this type of calculation [13].

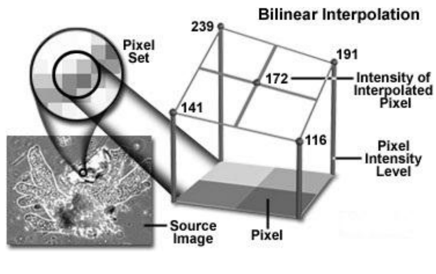


Figure 1. Bilinear Interpolation

An interpolation technique that reduces the visual distortion caused by the fractional zoom calculation is the **bilinear interpolation** algorithm, where the fractional part of the pixel address is used to compute a weighted average of pixel brightness values over a small neighborhood of pixels in the source image. Bilinear interpolation (see Figure 1) produces pseudo-resolution that gives a more aesthetically pleasing result, although this result is again not appropriate for measurement purposes.

C. *Bilinear Interpolation Algorithms*

Interpolation works by using known data to estimate values at unknown points. Image interpolation works in two directions, and tries to achieve a best approximation of a pixel's color and intensity based on the values at surrounding pixels. The following figure illustrates how resizing / enlargement works [14] :

2D Interpolation →

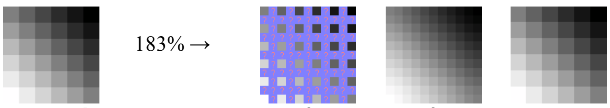


Figure 2. Image Resizing

Pixel values can change far more abruptly from one location to the next. As with the temperature example, the more we know about the surrounding pixels, the better the interpolation will become. Therefore results quickly deteriorate the more stretch an image, and interpolation can never add detail to image which is not already present.Depending on their complexity, these use anywhere from 0 to 256 (or more) adjacent pixels when interpolating. The more adjacent pixels they include, the more accurate they can become, but this comes at the expense of much longer processing time. These algorithms can be used to both distort and resize a photo [14].

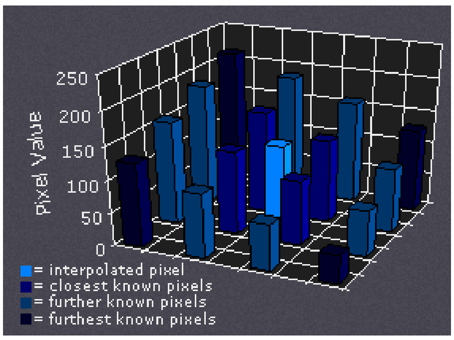


Figure 3. Visualize of bilinear interpolation

Bilinear interpolation considers the closest 2x2 neighborhood 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 neighbor.The diagram to the figure 6 is for a case when all known pixel distances are equal, so the interpolated value is simply their sum divided by four.

Scaling an image goes in two ways, making it larger or to make it smaller. By enlarging an image, some new pixels are constructed by means of interpolation. By shrinking, we are tempted to think the right pixels are selected to keep while the others are thrown away, but this is not the case. Unlike nearest neighbor shrinking where pixels are thrown, bilinear shrinking estimates a smaller resolution of the original image. Even though details are lost, almost all the new pixels in the shrunk image do not come directly from their original, but interpolated, indirectly keeping the properties of lost pixels. It should be understood this is not always the case, shrinking image to half size (and smaller) significantly reduce image quality – not much different from nearest neighbor shrinking. This also applies to sizing up more than double the original size [16].

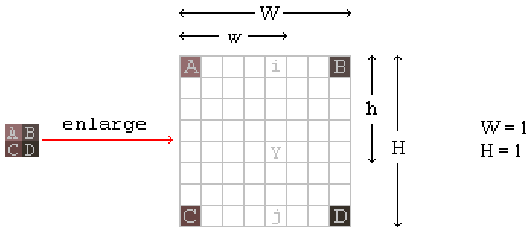


Figure 4. Enlarged image.

For the purpose of this article, explanation will follow the making-it-larger path. So we start by enlarging a small texture such as shown in figure 4. This is not to be mistaken as a requirement to enlarge every single texture found in an image. The objective is finding the colors for all white spaces, including i, j, and Y. First is to find the relation between A, i, and B. Using linear interpolation function (figure 4), we get this equation :

$$\frac{i-A}{w} = \frac{B-A}{W}$$

$$i = A + \frac{w(B-A)}{W}$$

$$i = A + w(B-A) \rightarrow 1 \qquad (1)$$

Do the same for C, j, and D and we get,

$$\frac{j-C}{w} = \frac{D-C}{W}$$

$$j = C + w(D-C) \rightarrow 2 \qquad (2)$$

Now we have two linear interpolation equations. Next is to combine the two equations forming a single equation that is called the bilinear function.

$$\frac{Y-i}{h} = \frac{j-i}{H}$$

$$Y = i + h(j - i) \rightarrow 3 \quad (3)$$

Substituting (1) and (2) into (3) we get,

$$Y = A + w(B - A) + h\left(C + w(D - C) - \left(A + w(B - A)\right)\right)$$

$$Y = A(1 - w)(1 - h) + B(w)(1 - h) + C(h)(1 - w) + D(wh) \quad (4)$$

Using (4), all white spaces can now be interpolated.

D. Filtering

Most images are affected to some extent by noise, disturbances in image intensity which are either uninterpretable or not of interest. Image analysis is often simplified if this noise can be filtered out. Image filters may be used to emphasise edges, the boundaries between objects or parts of objects in images. Filters provide an aid to visual interpretation of images, and can also be used as a precursor to further digital processing, such as segmentation. Filters change a pixel's value taking into account the values of neighbouring pixels too. They may either be applied directly to recorded images, or after transformation of pixel values. By utilizing the results of the Fourier transformation. Where the frequency of the image is affected by gradation of colors that exist in the image [7].

One method of filtering an image is to apply a convolution operation to the image to achieve: blurring, sharpening, edge extraction or noise removal. The action of a convolution is simply to multiply the pixels in the neighbourhood of each pixel in the image by a set of static weights and then replace the pixel by the sum of the product. In order to prevent the overall brightness of the image from changing, the weights are either designed to sum to unity or the convolution is followed by a normalization operation, which divides the result by the sum of the weights. In simple terms, perform a weighted average in the neighbourhood of each pixel and replace the pixel's value by the average. The filter is generated by providing a set of weights to apply to the corresponding pixels in a given size neighbourhood. The set of weights make up what is called the convolution kernel and is typically represented in a table or matrix-like form, where the position in the table or matrix corresponds to the appropriate pixel in the neighbourhood. Such a convolution kernel (or filter) is typically a square of odd dimensions, when applied, the resulting image does not shift a half pixel relative to the original image. The general form for a 3x3 convolution kernel looks as follows [17]:

$$\begin{bmatrix} w1 & w2 & w3 \\ w4 & w5 & w6 \\ w7 & w8 & w8 \end{bmatrix} \quad (5)$$

Orif the weights are not designed to sum to unity, then as

$$\frac{1}{sumw}\begin{bmatrix} w1 & w2 & w3 \\ w4 & w5 & w6 \\ w7 & w8 & w8 \end{bmatrix} \quad (6)$$

Where
sumw=(w1+w2+w3+w4+w5+w6+w7+w8+w9). (7)

The simplest convolution kernel or filter is of size 3x3 with equal weights and is represented as follows:

$$\begin{bmatrix} 1/9 & 1/9 & 1/9 \\ 1/9 & 1/9 & 1/9 \\ 1/9 & 1/9 & 1/9 \end{bmatrix} = \frac{1}{9}\begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix} = low\ pass\ filter. \quad (8)$$

This filter produces a simple average (or arithmetic mean) of the 9 nearest neighbours of each pixel in the image. It is one of a class of what are known as low pass filters. They pass low frequencies in the image or equivalently pass long wavelengths in the image, i.e. slow variations in image intensity. Conversely, they remove short wavelengthsin the image, which correspond to abrupt changes in image intensity, i.e. edges. Thus we get blurring. Also, because it is replacing each pixel with an average of the pixels in its local neighbourhood, one can understand why it tends to blur the image. Blurring is typical of low pass filters. Low Pass Filter is a filter process that takes images with smooth gradation of intensity and high intensity differences will be reduced or removed [17].

E. PSNR (Peak Signal to Noise Ratio) Analysis

The peak-signal to noise ratio is abbreviated as PSNR is defined as the ratio between signals maximum power and the power of the signals noise. The PSNR is commonly used to measure the quality of the reconstructed images which have been compressed. Each picture element is called as pixel which has color value that can change when an image is compressed and then uncompressed. Signals can have a wide dynamic range, so PSNR is usually expressed in decibels. The signal in this case is the original data and the noise is the error which is introduced due to compression. If the compressed image is closer to original image means which have lower PSNR ratio. The PSNR most easily defined via the mean square error (MSE) for two matrices I and K having dimension of m X n [15].

The PSNR most easily defined via the mean square error (MSE) for two matrices I and K having dimension of m X n. The MSE can be expressed as,

$$MSE = \frac{1}{mn}\sum_{i=0}^{m=1}\sum_{j=0}^{n=1}[I(i,j) - K(i,j)]^2 \quad (9)$$

The PSNR defined as,

$$PSNR = 10\log_{10}\left(\frac{255^2}{MSE}\right) \quad (10)$$

Where I and K represents the matrices that represent the images being compared. The two summations are performed for the dimensions 'i' and 'j' therefore I (i, j) represents the value of pixel (i, j) of image I. The PSNR is expressed in decibels. Typically values for the PSNR in lossy image and video compression are between 30db and 50db.

III. METHOD

The block diagram of the systemimage magnification using the combined method is shown in Figure 5. Image data used is the data image format JPG, BMP, PNG. The image data is carried out first process sampling the image with the desired region by the user, in terms of which regions in the input image to be localized for the magnification process.

After the sampling process is done, then the next step is image filtering process with lower pass filter method and bilinear interpolation.Then the obtained results is an average magnification of the results of the screening process down pass filter and bilinear interpolation. Image sampling process is one stage of the process used to produce a good magnification. The sampling process using the image (xL,yT) and (xR,yB) = coordinates of the upper left corner point and the lower right corner of the image will be sampled, in this case, the sampling is done is to cut a portion of the original image.

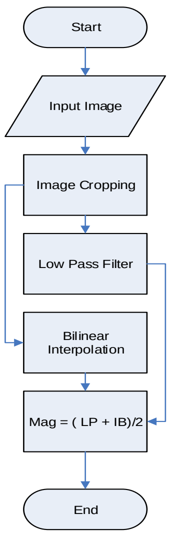


Figure 5. Image Magnification system

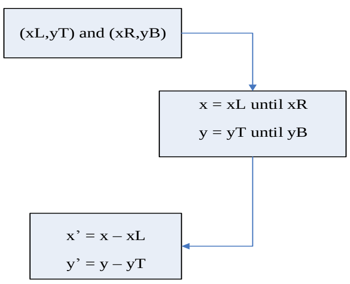


Figure 6. Image sampling process

After the sampling process is performed convolution process image with a low pass filter method, which uses filters in this process - average. The purpose of the process is done is to improve the quality of the original image. To throw a different point with its neighboring points (noise reduction process) then do Low - Pass Filter (LPF) , a filter that takes the form of data on low frequency and disposing of data at high frequencies . The algorithm is described as follows convolution process :

```
For x=0 to picture1.ScaleWidth-1
   For y=0 to picture1.ScaleHeight-1
      z(x,y)=0
      for k1=0 to nFilterX-1
         for k2=0 to nFilterY-1
(x,y)=z(x,y)+H(k1,k2)*I(x+k1,y+k2)
         next k2
      next k1
   next y
Next x
```

The analysis of an image in the frequency domain based on convolution techniques, generally give the output of a linear system can be obtained from the convolution operation between the system impulse response with the input signal. Convolution operation performed by sliding the kernel convolution pixels per pixel, calculate the output pixel f (i, j), and then save it in the new matrix. Convolution is very useful for screening operations (filtering) on the image. In digital image processing, convolution is done on a two-dimensional image.

TABLE I. MSE CALCULATION RESULTS FOR IMAGES WITH EXTENSION JPG , PNG AND BMP

No	Zoom	Size	Peak Signal to Noise Ratio(PSNR)		
			JPG	PNG	BMP
1.	2x	700 x 472	51.4446	51.5822	51.5694
	3x		51.4561	51.5769	51.5659
	4x		51.4594	51.5783	51.5635
	5x		51.4664	51.5478	51.5619
2.	2x	500 x 800	51.4530	51.6784	51.6706
	3x		51.4539	51.6763	51.6665
	4x		51.4585	51.6669	51.6640
	5x		51.4521	51.6169	51.7624
3.	2x	1600 x 1400	55.5323	57.6355	57.7354
	3x		56.1244	57.7243	57.7347
	4x		56.4123	58.9997	57.6365
	5x		56.7465	58.3857	57.7545

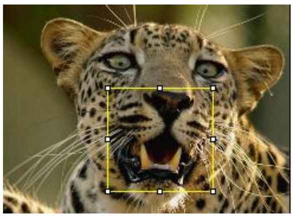
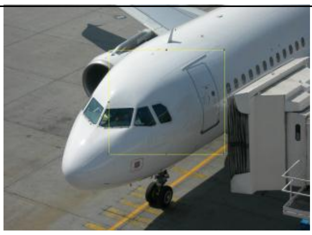
TABLE II. THE RESULTS OF THE CALCULATION OF PSNR FOR IMAGE WITH EXTENSION JPG , PNG AND BMP

No	Zoom	Size	Mean Square Error (MSE)		
			JPG	PNG	BMP
1.	2x	700 x 472	0.454	0.452	0.443
	3x		0.453	0.457	0.443
	4x		0.463	0.456	0.443
	5x		0.453	0.456	0.443
2.	2x	500 x 800	0.466	0.459	0.443
	3x		0.466	0.458	0.443
	4x		0.468	0.459	0.443
	5x		0.468	0.459	0.443
3.	2x	1600 x 1400	0.453	0.634	0.623
	3x		0.464	0.652	0.687
	4x		0.465	0.635	0.614
	5x		0.475	0.652	0.634

IV. TEST AND RESULT

The trial results of this research through several stages of the captured image magnification is performed on twelve different trials. Scale enlargement as well as the different image sizes. The scale difference between the sizes in multiresolution is still limited in the fidelity. However, with image processing technology it can be possible to achieve an arbitrary degree of fine detail using a multiresolution representation. In addition to alleviating some of the limitations, multiresolution representations often yield other advantages over uniresolution representations, there is in control, feature detection, compression, and refinement. A representation in multiresolution image, that accommodates different amounts of detail in different parts of the image.

TABLE III. THE RESULTS IMAGE FROM DIFFERENT SCENE

2x		
3x		
4x		
5x		

From the test results in Table 1, it can be seen that the input image used is the original image that has undergone a process of cutting first with different sizes. Magnification scale is used to make the process of enlargement on each image is different. From Table 1 it can comparing the value of the Mean Square Error (MSE) at each image file extensions are tested.Location of sampling performed well at different locations. The effect of different trials is determine the advantages and disadvantages of this method on digital image magnification. At trial magnification image, a large image of different sizes as well as to determine the value of MSE and PSNR of the magnify iamges. In Table 2 can also be seen that the value of Peak Signal to Noise Ratio (PSNR) which is the smaller the greater the value of MSE and the PSNR value the better the resulting image. In table 1 and 2 can also be seen that the greater the magnification is done then the smaller value of MSE and its PSNR higher. Evaluation results of this pilot study is an attempt magnification image that has been done that the application and the methods used for proper operation in accordance with its function. Although the MSE and PSNR image jpg extension is better than the image bmp extension. This is because the image of the extension jpg is a lossy format, while the extension bmp image is a lossless format, so that the image quality is better. Although if at first glance would not look at all. In addition, the enlarged image do have a higher image quality. This method is designed to reduce the contrast of the image enlarged.

V. CONCLUSION

The conclusion of the research is that the value of MSE is smaller and PSNR value greater than the other methods. By using this combined method produces smoother image but not too appear blurring impression. In this study the process time required magnification is strongly influenced by the size of the image is done bycropping process. In the next stage, this research can be developed by using more robust method in dealing with images sharper color depth and integrate with motion capture system. The speed of the process is also one of the measures that are used when processing the image with a variety of conditions. Applications can also be developed into applications that unsupervised or automatic, both from the beginning of the process to the expected output. In addition to robustness, the method can also be developed into a more adaptive methods.

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