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# Application of Interpolation Image by using Bi-Cubic Algorithm

**Dahlan Abdullah[1*], F Fajriana[1], M Maryana[1], Lidya Rosnita[1], Andysah Putera Utama Siahaan[2], Robbi Rahim[2], P Harliana[3], H Harmayani[4], Zainuddin Ginting[5], Cut Ita Erliana[6], Defi Irwansyah[6], Z Zulmiardi[7], Muammar Khaddafi[8], Feby Milanie[9], Henry Aspan[9], Ismul Huda[10], Kundharu Saddhono[11], Indrya Mulyaningsih[12], Roy Marthen Moonti[13], Parwito[14], Hardianto Djanggih[15], Ainna Amalia[16], Edy Winarno[17] and Wiwien Hadikurniawati[17]**

[1]Department of Informatics, Universitas Malikussaleh, Aceh, Indonesia
[2]School of Computer and Communication Engineering, Universiti Malaysia Perlis, Malaysia
[3]Department of Informatics Engineering, Sekolah Tinggi Teknik Harapan, Medan, Indonesia
[4]Department of Informatics, AMIK Intel Com Global Indo, Indonesia
[5]Department of Chemical Engineering, Universitas Malikussaleh, Aceh, Indonesia
[6]Department of Industrial Engineering, Universitas Malikussaleh, Aceh, Indonesia
[7]Department of Mechanical  Engineering, Universitas Malikussaleh, Aceh, Indonesia
[8]Department of Accounting, Universitas Malikussaleh, Aceh, Indonesia
[9]Universitas Pembangunan Panca Budi, Medan, Indonesia
[10]Universitas Syiah Kuala, Aceh, Indonesia
[11]Graduate Program, Universitas Sebelas Maret, Surakarta, Indonesia
[12]Indonesian Language Teaching Department, Institut Agama Islam Negeri Syekh Nurjati Cirebon, Indonesia
[13]Department of Law, Universitas Gorontalo, Gorontalo, Indonesia
[14]Department of Agrotechnology, Universitas Ratu Samban, Bengkulu, Indonesia
[15]Department of Law, Universitas Tompotika Luwuk Banggai, Luwuk, Indonesia
[16]Islamic Institut of Miftahul Ula Kertosono Nganjuk, East Java, Indonesia
[17]Faculty of Information Technology, Universitas Stikubank, Semarang, Indonesia

*dahlan@unimal.ac.id

**Abstract.** Image magnification is one of the branches in digital image processing that is often required in various applications such as in the field of medicine, multimedia, and in satellite imagery. As technology grows, more and more methods are used for image enlargement. In this study, the image enlargement process performs by using Bi-Cubic spline interpolation method, and the result of image try to compare between the original one and picture after enlargement.

## 1. Introduction

The rapid development of computers today is constructive for humans to simplify and accelerate their work in all aspects of life. Delivery of data between two geographically dispersed areas can do in seconds, and significant data processing is done in a short time, one of the emerging technologies is the technology of shooting image.

The current shooting image can be done quickly using a smartphone with a very high resolution, this ease dramatically supports the importance of image processing [1, 2, 3] and picture quality improvement [1, 2, 3], but not all shooting image is performed with smartphones as well, another one using media such as CCTV. An image from CCTV is less clear and also the resolution is much smaller than smartphones [4], for small resolution problems can be accomplished by using zooming an image and hope the images become much more clear.

One way to solve the small resolution problem on zooming image [5] is to apply the Bi-Cubic interpolation [6] [7] [8] algorithm. Parsania [9] explained in his research that the image enlargement process can be done well using adaptive technique but it takes longer time, different with Wei-Chen Wu [8] using cubic spline interpolation with Edge curve scaling and smoothing technique to enlarge the image with good result but also takes a longer time.

Some of the previous Bi-Cubic Interpolation [10] [8] research has been discussed by Wu [8] in title *Edge Curve Scaling and Smoothing with Cubic Spline Interpolation for Image Up-Scaling* the experiment result can maintain the contour of the pixel and improve the sharpness of image [8]. Based on some research results, the authors feel interested in examining more deeply about Bi-cubic Spline Algorithm in the application, so it is known whether the quality of the resulting image by an algorithm or not.

## 2. Methodology

An ordinary Image already in two dimensions form [1] [11] [9]. From a mathematical point of view, the image is a continuous function of the intensity of light in a two-dimensional plane [11]. The light source illuminates the object, and the object reflects back part of the beam. This light reflection is captured by optical devices, such as the human eye, the camera and the scanner (scanner).

Image interpolation [7] occurs in all digital photos at a particular stage, such as during photo enlargement process. This happens whenever resizing or remapping (distorting) an image from one-pixel box to another. Image enlargement is necessary when it needs to increase or decrease the number of pixels, while mapping can occur in a wide variety of scenarios: correct lens distortion, change perspective and rotate images.

Bi-Cubic interpolation is an extension of cubic interpolation. Bi-cubic interpolation can be achieved using either Lagrange polynomials, cubic splines, or cubic convolution algorithms. In image processing, Bi-Cubic interpolation is often chosen over bilinear interpolation when process speed is not a problem. The resampled image of the Bi-Cubic interpolation is more subtle than Cubic Interpolation. The model the Bi-Cubic interpolation method can be exemplified by the functional value f and the derivatives fx, fy and fxy known at all four angles (0, 0), (1.0), (0.1), and (1, 1) of the units square, then the formula can be written as:

$$p(x,y) = \sum_{i=0}^{3} \sum_{j=0}^{3} a_{ij}\, x^i y^j$$

Application of image enlargement by applying Bi-Cubic algorithm designed by using Visual C # language on Microsoft Windows 7 platform, the test is done with some image with varying image size, the size of the enlargement is also done with dynamic size so that the result of the expansion with various sizes.

### 3. Result and Discussion

Image zooming will change pixel density over the new mapping space that has been created, where the pixel size remains but the mapping space changes. Image magnification is done by increasing the size of the picture, this magnification will make a void pixel in the picture, and the zooming result looks like fragmented. The zoom image results in a widening occurring with a width (W) and height (H) image can write as formula below:

$W = W \times 2$
$H = H \times 2$

The bi-cubic interpolation algorithm works by estimating the color in an image pixel by calculating the average of 16 pixels residing around pixels that are similar to pixels in the source image, and the formula below gives an interpolation result applied to each component of red, green and blue. The last presentation m and n have a 4 x 4 grid length around pixels (i, j).

$$F(i', j') = \sum_{m=-1}^{2} \sum_{n=-1}^{2} F(i + m, j + n) R(m - dx) R(dy - n)$$

The function of the color values for bi-cubic expressed in R (x) could see below:

$$R(x) = \frac{1}{6}[P(x + 2)^3 - 4\,P(x + 1)^3 + 6\,P(x)^3 - 4\,P(x - 1)^3]$$

$$P(x) = \begin{cases} x & x > 0 \\ 0 & x \le 0 \end{cases}$$

For the pseudocode process of the Bi-Cubic algorithm as follows:

```
Function 'Cubic_BSpline(X#)
    If X < 2 Then
        tmp = X + 2
        If tmp > 0 Then a = tmp * tmp * tmp
        tmp = X + 1
        If tmp > 0 Then B = 4 * tmp * tmp * tmp
        If X > 0 Then c = 6 * X * X * X
        tmp = X – 1
        If tmp > 0 Then d = 4 * tmp * tmp * tmp
        Cubic_BSpline = (a – B + c – d) / 6
    End If
End Function
```
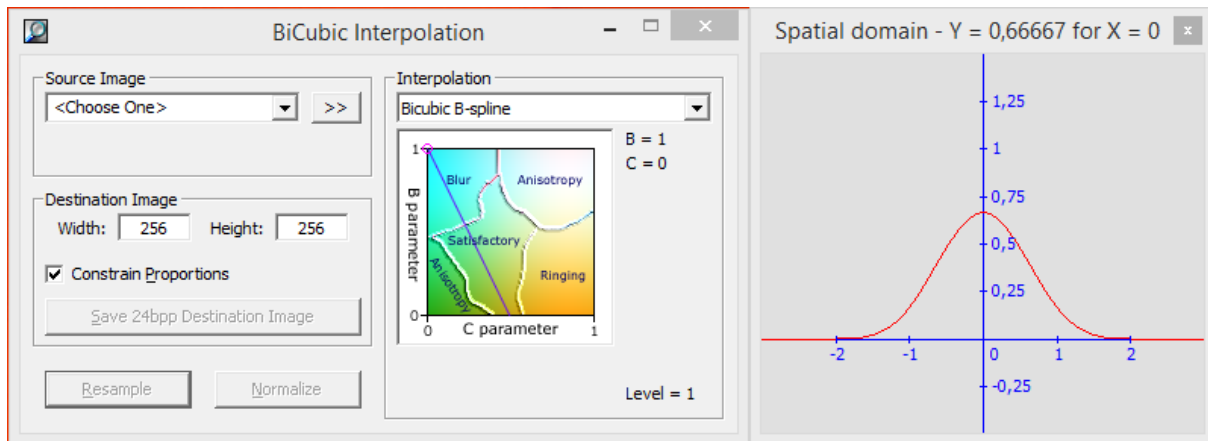
For experiment image enlargement using application by applying the Bi-Cubic algorithm, the result of implementation can be seen as follows:

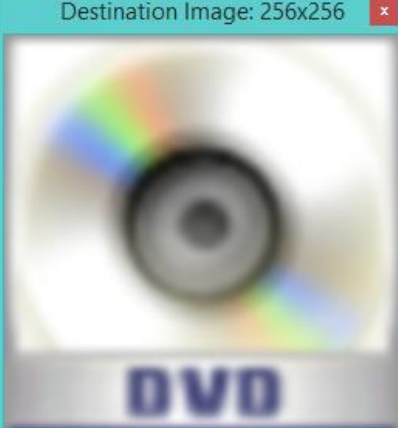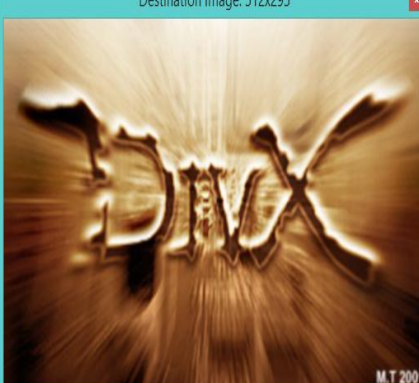**Figure 1**. Bi-Cubic Application
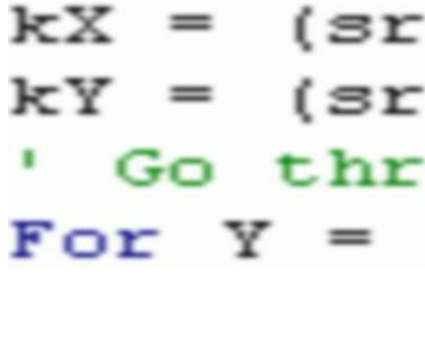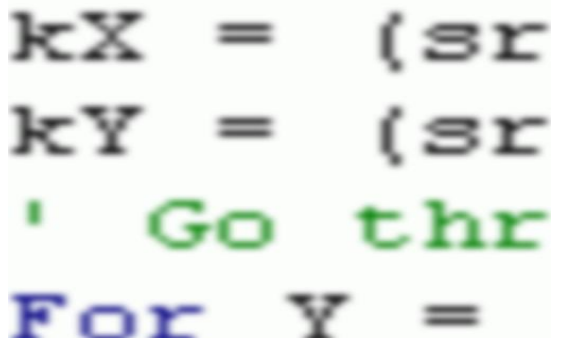
For example, image enlargement testing is used in the picture with size 48 x 48, and the image is then enlarged with the size 256 x 256, here is the result of magnification with applications that implement the Bi-Cubic algorithm.
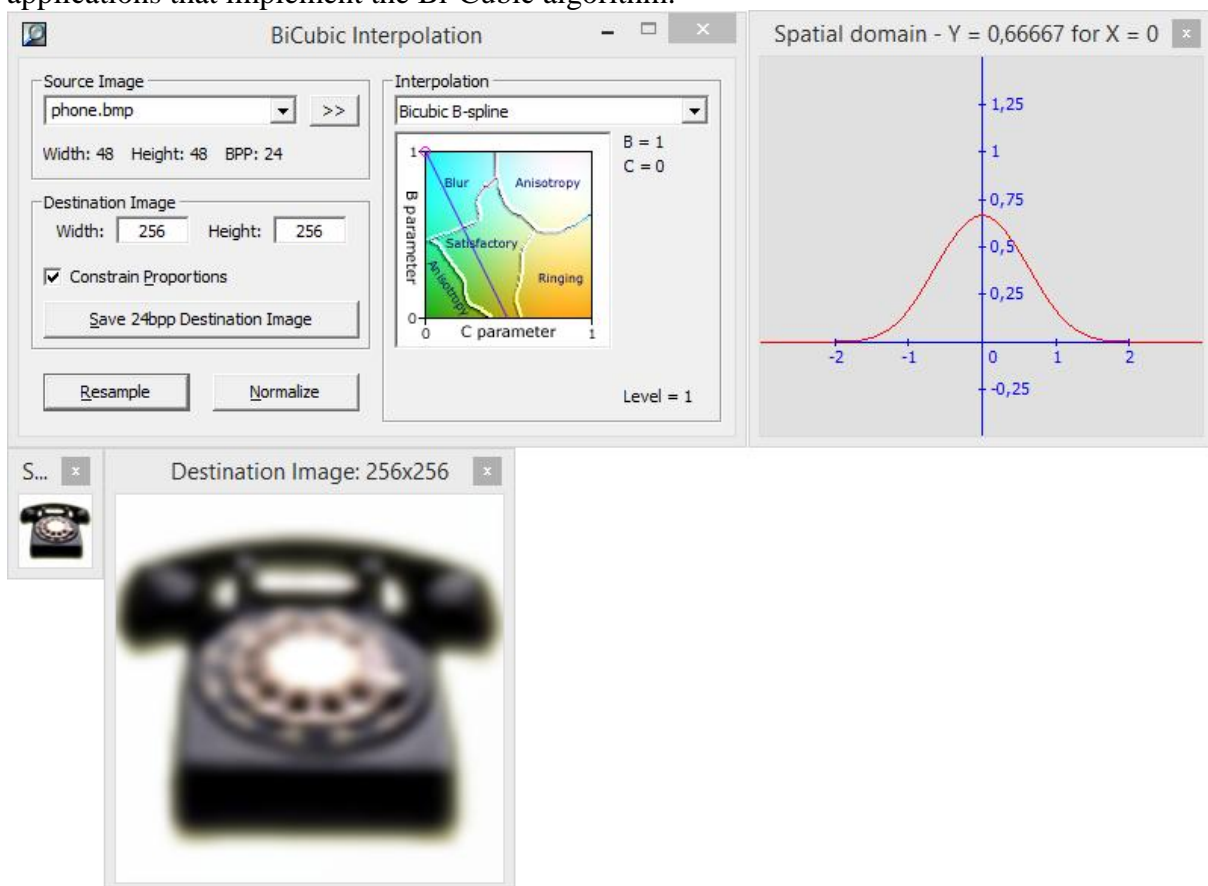


**Figure 2**. Bi-Cubic Result Application

Based on the tests performed, the image with Bi-Cubic method led to a reasonably bright image from the initial image, here are some results of image enlargement performed from several objects of different sizes:

**Table 1**. Different Sample Results

| Image Source (w x h) | 256 X 256 | 400 X 400 |
|---|---|---|
| 48 x 48 |  |  |
| 309 x 178 |  |  |
| 64 x 64 |  |  |

Based on the experiment of image enlargement with a Bi-Cubic algorithm to some image with the variation of size, it obtained of good enough result enlargement and clear image too, experiments performed with the same image object using different algorithms such as Spline and Bell produce fairly good enlargement results although with some processes requiring a long time, compared to the Bi-Cubic algorithm is still faster with good results.

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## 4. Conclusion

The use of a Bi-Cubic algorithm in image enlargement process can be done well with the various initial size of image, image enlargement result also bright to be seen visually. Subsequent research can combine several algorithms or compare some algorithms such as linear interpolation, Spline, Bi-Cubic Spline to determine the performance of each algorithm in doing image enlargement.

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