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A Proposed Image Scaling Technique by Using Bezier Curve

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Abstract

The process of resizing a digital image using geometrical transformation without changing the quality of image is known as image scaling or image resizing. Image processing such as digital image scaling has a wide range of applications on computer, mobile, and other digital devices. This paper proposes a digital image resizing (scaling) approach and explaining how the algorithms have been modified to meet accuracy and performance. Bezier curve have been used in previous works for processing in various fields while in this paper Bezier curve equations used to resize the digital image (scaling-up or scaling-down). The idea of using Bezier curve polynomial for image resizing comes from the interpolation feature of the points that located on the curve. The quality of the resized images based on the scaling factors and the control points used in Bezier curve. This work will be a useful resource for researchers who intend to apply image scaling to a real-world application because it provides a fast approach for image resizing. Mean Square Error (MSE), Peak Signal to Noise Ratio (PSNR), and Signal to Noise Ratio (SNR) have been used to define the resolution of the reconstructed image. The measurements between the original image and the reconstruct image give acceptable results. The best results was found when the control points are even (n=1(0,1), n=3(0,1,2,3), …) the image will be scaled-down exactly to (1/2,1/3,1/4,….) width and height of the original image based on the scaling factor, and scaled-up to (x2, x3, x4, …) width and height of its original size based on the scaling factor, while when the control points are odd (n=2(0,1,2), n=4(0,1,2,3,4), …) the image will be scaled-down and scaled-up but some of image will be lost where the amount of lost will be based on the scaling factor.

Keywords: Bezier curve, Image scaling, Scaling-Up, Scaling-Down, scaling factor.

Introduction

The images become an essential part for providing information in many scientific, medical, and engineering fields. A digital image composed of a matrix where every point in the matrix is a pixel in the image and represents a color or intensity. Image processing can be categorized into two main types: modify the show of the image and adding a dimensionality to the image data. The most common tasks of modifying the show of the image are transforming, translating, rotating and resizing images that are used to focus the viewer's attention on a specific area of the image while adding a dimensionality to the image data shows how to display the images over surfaces and geometric shapes[1,2]. The process of image scaling is an image's resizing where the dimensions or resolution of a digital image will be changed from one to another by avoiding the loss of visual information. There are number of names for image scaling like interpolation, re-sampling, zooming, magnification, and others[3]. The digital image may be scaled by two ways: up-scaling/up-sampling and down-scaling/down-sampling, where up-scaling produces larger image according to specific condition while down-scaling produces smaller image[4]. B´ezier curves play an important role in image hiding[5], enhancing the degraded image[6,7], printing a high speed curve that used to represent fused deposition molded parts[8], improving low light images[9], spotting the curved text[10], detecting face expression[11], reconstructing a panoramic image[12], image segmentation[13], enhancing a medical images[14]. Medical Applications, Computer Aided Design (CAD) and Computer Aided Geometric Design (CAGD), these curves are also used in solving some important equations such as heat and wave equations, partial differential equations addition to dynamical systems [15,16]. The following is the framework for this paper: section 2 presents some related works that have similar objectives to this work. Section 3 and section 4 present the theoretical background of the Bezier curve and the images scaling respectively. Section 5 presents the proposed method. Section 6 presents the experimental results and discussion. Section 7 presents the conclusions.

Related Works

The advantages and disadvantages of a common scaling methods and an improved image scaling method that depends on fraction interpolation and multi-resolution hierarchical processing have been defined. The experimental results show that the edge of the target image obtained by the algorithm in this paper is clear, and the algorithm complexity is low, which is convenient for hardware implementation and can realize real-time image scaling[17]. An improved coarse and smooth interpolation for image based on fuzzy gradient interpolation and area based interpolation respectively have been defined. PSNR and MSE shows low error rate for the proposed method[18]. The image scaling done by using a proposed spline surfaces method. First reduce the original images 4 times by bilinear interpolation, and then the proposed method and some other methods listed in this paper are used to scale the contractible images 4 times respectively. By comparing the experiment effects between the proposed method and other methods, the experiment results with the corresponding edge detection, where the free parameters in this work are taken as the optimal values that can make the PSNR as high as possible[19]. Discrete Wavelet Transform (DWT) with downscaling technique has been applied on a gray scale digital image. Inverse Discrete Wavelet Transform (IDWT) with different interpolation techniques for upscaling has been used to recover the original image. The interpolation techniques that have been used are: Nearest Neighbor, Bilinear and Bicubic. Peak Signal to Noise Ratio (PSNR) and Mean Square Error (MSE) is calculated for quantifying interpolated image effectiveness. Results show that the reconstructed image is better when using a combination of DWT and Bicubic interpolation[4]. An efficient interpolation algorithm for image scaling is proposed with an enhancement scheme where the original image (input image) with a scaling factor using to create two reference images. The first image is an image with high resolution and the second image is an image with lower resolution. The two intermediate images will create from the referenced images. At the end the scaled image came from the intermediate images. The algorithm provides a high image quality (by using PSNR) when compared with the other interpolating techniques such as Bilinear Interpolation, B-Spline interpolation, Lanczos interpolating methods[3]. Log-polar neighbor model has been used for image scaling by giving more weights for the center pixels while the weights of pixels far from the center will be decreased logarithmically. There is no need for full image’s transformation to log-polar because the interpolation will be done on the Cartesian. Experiments show that in both visual comparisons and quantitative analysis, the results extracted by the proposed log-polar neighbor model are better than those extracted from pixel repetition, bilinear, and bicubic interpolation[20].

B´ezier Curve

An automobile designer was the first who evolve the Bezier curve for the purpose of describing the shape of exterior car panels. Bezier curve is an easy type of spline. Bezier curve f(t) of n degree with (n+1) control points is a parametric function expressed by Eq. 1 [15,21]. The polynomials with degree three are the most popular type of Bezier curves, and it will be defined by 4 control points P_0, P_1, P_2, P_3. The Bezier curve polynomial will interpolate all control points that located on the curve unless the first and the last points. Bernstein polynomials with four control points (degree three) are defined by b_i^3. Fig. 1 shows an example the Bezier curves with degree three that have four control points [21,22].

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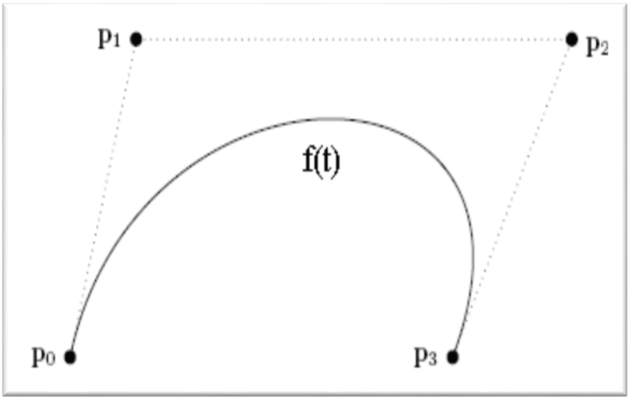

Figure 1. A degree three B´ezier curve f(t).

The public form of a Bezier Bernstein polynomial f(t) for (n) degree as follows:

$f(t) = \sum_{i=0}^{n} b_i^n(t)\ P_i$, where $0 < t \leq 1$ … 1

where, P_i (P_0, P_1, P_2, …, P_n) are the control points or the guide points for the curve f(t), t is the time measure for changing the scalar value by time,

$b_i^n(t)$ called a Bernstein polynomial or the blending function (as a base function which determine the curve's shape) can be computed by Eq. 2:

$b_i^n(t) = \binom{n}{i}\ t^i\ (1-t)^{n-i}$ … 2

Where, $\binom{n}{i}$ is the binomial coefficient, A binomial coefficients, commonly derived from Pascal's triangle, and can be computed by using Eq. 3: [15, 21, 23-25]

$\binom{n}{i} = \frac{n!}{i!(n-i)!}$ … 3

Scaling Image

Scaling or resizing a digital image is the most frequently used operation for processing image. The idea of scaling any digital image is to produce an image with different resolutions or dimensions. The new scaled image will be smaller or larger than the original image, or the same size of the original image according to the scaling factor. The scaling or resizing of the digital image will create a contest among smoothness, sharpness, and efficiency. There are two classes of the interpolation methods for image: non-adaptive and adaptive. The non-adaptive interpolation methods process the image without the need to the features of the processed image, while the adaptive methods process the image's features and content. The process of down-sampling (down-scaling) will produce image with lower resolution or dimension while the process of interpolating the image to higher resolution or dimension called up-sampling (up-scaling). There are many applications of image resizing such as applications in computer graphics region, resizing medical image, and maximize or minimize the size of the image in HD tv [3,4,26,27].

The Proposed Image Scaling Method

Bezier curve equation will be used as an x and y equations by substitute the value of x coordinate point in Eq.1 and create new value for x and substitute the value of y coordinate point in Eq. 1 and create new value for y. Multiplying each polynomial of X_{new} and Y_{new} equation by Z (which is the scaling factor) will scaling-down the image according to the value of Z as in Eqs. 4 and 5.

$X_{new} = \sum_{i=0}^{n} b_i^n(t)\ X_i * Z$ … 4

$Y_{new} = \sum_{i=0}^{n} b_i^n(t)\ Y_i * Z$ … 5

For example, when the value of Z=2, the image will be scaled-down to the half of original width and height. The scaling factor (Z) will resize the height (the number of rows) when multiply by X equation and resize the width (the number of columns) when multiply by Y equation. For scaling-up the image the x and y coordinates of the current image will be substituted by Eq. 1 to create new coordinates X_{new} and Y_{new} as in the scaling-down process but instead of multiplying the results X_{new} and Y_{new} by a scaling factor (Z), dividing the X_{new} and Y_{new} by a scaling factor (Z) to scaling-up the height and width of the current image respectively as in (Eqs. 6 and 7). For example, when the value of Z=3, the image will be scaled-up to the 3 times of its original size 3xwidth and 3xheight. The proposed image scaling method for scaling-up and scaling-down image has shown in Fig. 2.

$X_{new} = \sum_{i=0}^{n} b_i^n(t)\ X_i\ /\ Z$ … 6

$Y_{new} = \sum_{i=0}^{n} b_i^n(t)\ Y_i\ /\ Z$ … 7

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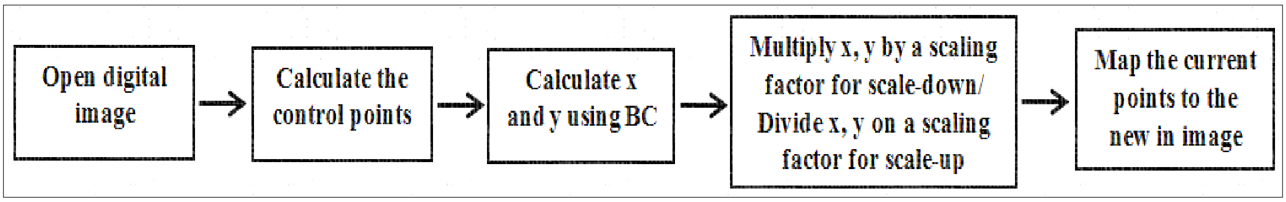

Figure 2. Block diagram for scaling-up and scaling-down.

Algorithm One: Scaling-Down Image by Using Bezier curve.
Input: Digital image, scaling-down factor, number of control points, time step, original (x,y) coordinates.
Output: scaled-down image.
Step 1: Open a digital image,
Step 2: Calculate the control points for Bezier curve,
Step 3: Calculate the new point X_{new},Y_{new} by using Bezier curve Eqs. 4 and 5 multiplied by the scaling factor,
Step 4: Map the current point to the new calculated point,
Step 5: End.

Algorithm Two: Scaling-Up Image by Using Bezier curve.
Input: Digital image or scaled-down image, scaling-up factor, number of control points, time step, original (x,y) coordinates.
Output: scaled-up image.
Step 1: Open a digital image or use the scale-down image to be scaled-up,
Step 2: Calculate the control points for Bezier curve,
Step 3: Calculate the new point X_{new},Y_{new} by using Bezier curve Eqs. 6 and 7 multiplied by scaling factor,
Step 4: Map the current point to the new calculated point,
Step 5: End.

Results and Discussion

The program has been written by using VisualBasic.Net 2013 and windows7 operating system with processer core i5@2.67GHz and 4GB for RAM. There are three images different in size and content that have been used for testing the proposed approach as shown in Fig. 3.
When the number of control points are even (n=1, n=3, n=5, n=7, …), the image will scale-down, scale-up exactly to (1/2,1/3,1/4, ...) width and height based on the scaling factor (Z) while when the number of control points are odd (n=2, n=4, n=6, n=8, …) the image will scale-down, scaled-up exactly only when the scaling factor larger than the number of control points otherwise the image will be scaled to some degree as in Table 1. Notice that number of control points n start from 0.

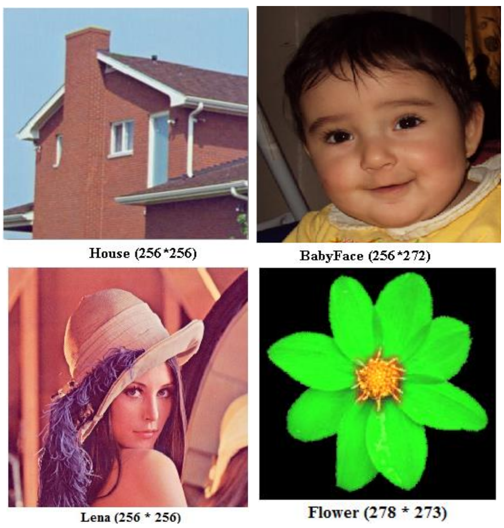

Figure 3. Testing images samples.

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Table 1. Scaling Information.

Case No.	n (number of control points)	Scaling-down Factor (Z)	Output	Scaling-up Factor (Z)
Case (1)	n=1, b_0,b_1	BezierCurve Eq. x 2	4 images (2x2) scale-down exactly	BezierCurve Eq./2
Case (2)	n=1, b_0,b_1	BezierCurve Eq.x 3	9 images (3x3) scale-down exactly	BezierCurve Eq./3
Case (3)	n =1, b_0, b_1	BezierCurve Eq.x 4	16 images (4x4) scale-down exactly	BezierCurve Eq./4
Case (4)	n = 2, b_0, b_1, b_2	BezierCurve Eq.x 2	4 images (2x2) not scale-down exactly	BezierCurve Eq./2
Case (5)	n =2, b_0, b_1, b_2	BezierCurve Eq.x 3	9 images (3x3) not scale-down exactly	BezierCurve Eq./3
Case (6)	n = 2, b_0, b_1, b_2	BezierCurve Eq.x 4	16 images (4x4) not scale-down exactly	BezierCurve Eq./4
Case (7)	n = 3, b_0, b_1, b_2, b_3	BezierCurve Eq. x 2	4 images (2x2) scale-down exactly	BezierCurve Eq./2
Case (8)	n = 3, b_0, b_1, b_2, b_3	BezierCurve Eq.x 3	9 images (3x3) scale-down exactly	BezierCurve Eq./3
Case (9)	n = 3, b_0, b_1, b_2, b_3	BezierCurve Eq.x 4	16 images (4x4) scale-down exactly	BezierCurve Eq./4

In case-1(two control points), case-4(three control points), and case-7(four control points) every image will be scaled-down to the half of the original image width and height. The image has been scaled-down to (2x2) images because Eqs. 4 and 5 multiplied by 2 as scaling factor. In case-2(two control points), case-5(three control points), and case-8(four control points) every image will be scaled-down to 1/3 width and height of the original image. The image has been scaled-down to (3x3) images because Eqs. 4 and 5 multiplied by 3 as scaling factor. In case-3(two control points), case-6(three control points), and case-9(four control points) every image will be scaled to 1/4 width and height of the original image. The image has been scaled-down to (4x4) images because Eqs. 4 and 5 multiplied by 4 as scaling factor. In the other side the scale-up to 2ximage width and height, 3ximage width and height, or 4ximage width and height will be done by applying Eqs. 6 and 7 and the scaling factor are 2, 3, 4 respectively.

In the experimental results scaling-up have been applied on the scaled-down images (the same scaling-down factor will be used for scaling-up to reconstruct the original size of the scaled-down image and check the algorithm), the value of t = (0.1). The value of (t) will affect the results of scaling images up and down especially when the number of control points are odd and it can be [0.1, 0.2, 0.3, 0.4, 0.5]. The values of t = [0.6 - 0.9] will give the same results as the values t = [0.1 - 0.4] this mean 0.1 gives the same result as 0.9 and 0.2 gives the same results as 0.8 and so on. The original image and the reconstructed image have been used with objective quality measures MSE, SNR, and PSNR as in Eqs. 8, 9 and 10 respectively for experimental results. The resolution of the scaling-up (reconstructed) image will decrease by increasing the number of control points, the value of t, and the scaling factors as shown in the experimental results in Table 2.

$$MSE = \frac{1}{H \times W} \sum_{y=0}^{h-1} \sum_{x=0}^{w-1} (f(x,y) - f'(x,y))^2 \quad \text{.........8}$$

$$SNR = \frac{\sum_{y=0}^{H-1} \sum_{x=0}^{W-1} (f(x,y))^2}{\sum_{y=0}^{H-1} \sum_{x=0}^{W-1} (f(x,y) - f'(x,y))^2} \quad \dots 9$$

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

Where, MSE: is the Mean Square Error, *f*(x,y): is a matrix of the original image,

f ′(x,y): is a matrix of the reconstructed image at row(x), column(y),

H, *W*: is the image's height and image's width respectively.

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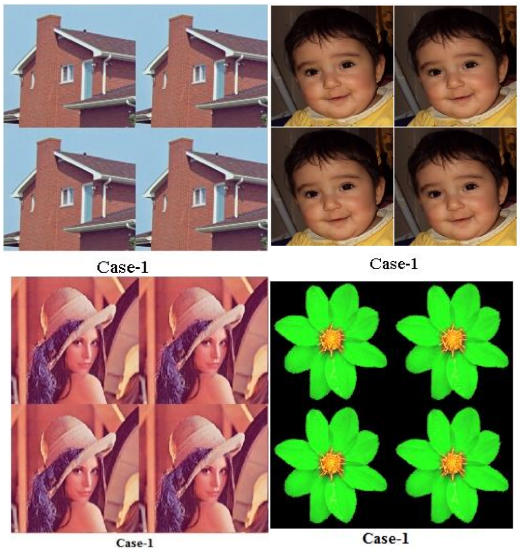
The most common used objective image quality measure is MSE, SNR, and PSNR[28]. The smaller value of MSE means better reconstructed image representing the original image. Larger SNR and PSNR indicate a smaller difference between the original and the reconstructed image (without noise) [29,30,31,32].

To evaluate the effectiveness of the proposed method the objective measures (MSE, SNR and PSNR) were used on colored images (House, BabyFace, Lena, and Flower). The experimental results for case-1, case-2, case-3, case-4, case-5, case-6, case-7, case-8, and case-9, with scale-up images and scale-down images will be shown sequentially in Tables 2, 3, 4, 5, 6, 7, 8, 9, and 10. The best results in general found in case 1 and case 7 for different images size and types.

Table 2. Case-1.

Case number	Image	MSE	SNR	PSNR
Case (1)	House	**100.826**	**215.1769**	**28.0951**
	BabyFace	**220.5476**	**40.337**	**24.6958**
	Lena	35.2065	18.5128	**22.6382**
	Flower	9.6283	923.4902	13.4628



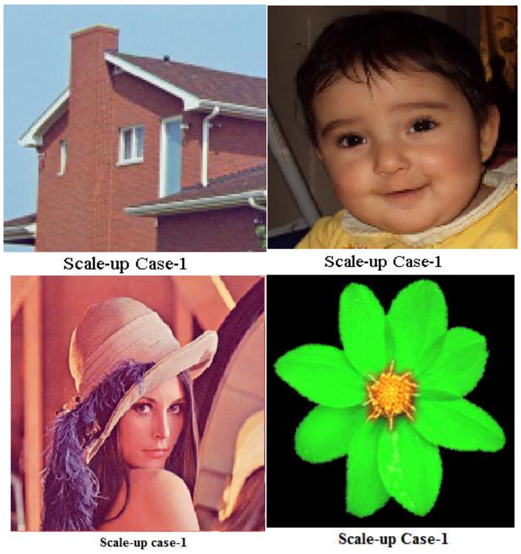
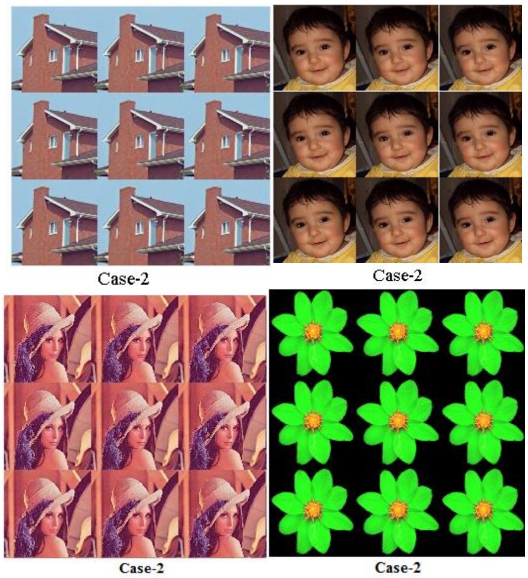


Table 3. Case-2.

Case number	Image	MSE	SNR	PSNR
Case (2)	House	185.4466	116.9901	25.4486
	BabyFace	225.1909	39.5052	24.6053
	Lena	46.7908	**25.3012**	19.6827
	Flower	14.6813	301.0879	13.2342



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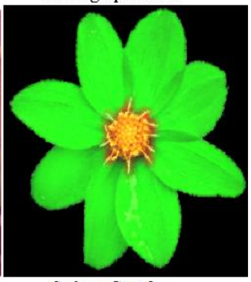
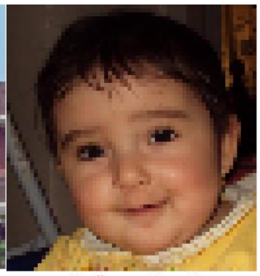
Scaling-up Case-2


Scaling-up Case-2


Scale-up case-2


Scale-up Case-2


Scaling-up Case-3


Scaling-up Case-3


Scale-up case-3


Scale-up Case-3

Table 4. Case-3.

Case number	Image	MSE	SNR	PSNR
Case (3)	House	234.4771	92.5269	24.4298
	BabyFace	416.9959	21.3341	21.9295
	Lena	43.7516	18.9778	20.2310
	Flower	13.3488	324.3974	13.3015

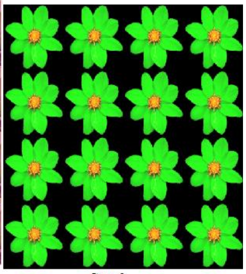
Table 5. Case-4.

Case number	Image	MSE	SNR	PSNR
Case (4)	House	1114.388	19.4685	17.6604
	BabyFace	1144.746	7.7714	17.5437
	Lena	109.2572	12.7882	12.3826
	Flower	46.1234	8.7356	8.5581


Case-3


Case-3


Case-3


Case-3


Case-4


Case-4


Case-4

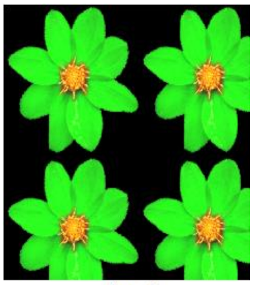

Case-4

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Table 6. Case-5.

Case number	Image	MSE	SNR	PSNR
Case (5)	House	1122.3538	19.3303	17.6295
	BabyFace	1159.4263	7.673	17.48837
	Lena	109.0477	12.8722	12.3917
	Flower	46.0392	8.7961	8.5635

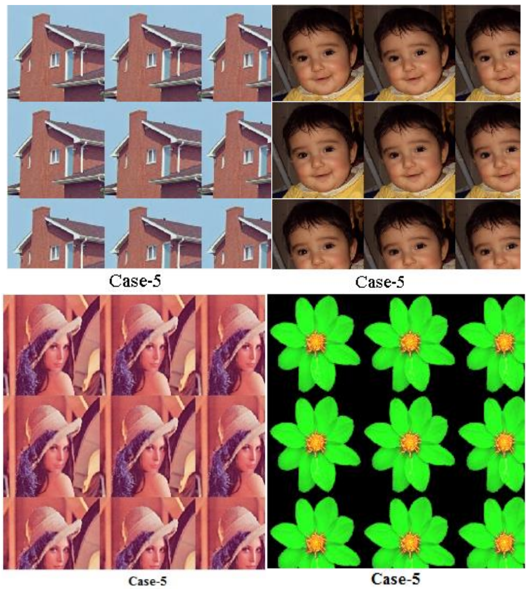

Table 7. Case-6.

Case number	Image	MSE	SNR	PSNR
Case (6)	House	1652.3997	13.1297	15.9497
	BabyFace	1475.6821	6.0286	16.4409
	Lena	108.8179	12.6960	12.4038
	Flower	46.1261	8.7301	8.5629

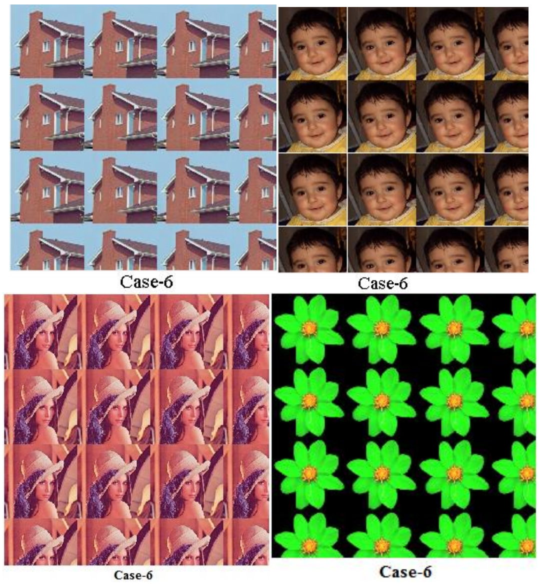

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Table 8. Case-7.

Case number	Image	MSE	SNR	PSNR
Case (7)	House	**100.826**	**215.1769**	**28.0951**
	BabyFace	**220.4008**	**40.3638**	**24.6987**
	Lena	35.2065	18.5128	**22.6382**
	Flower	9.6283	923.4902	13.4628

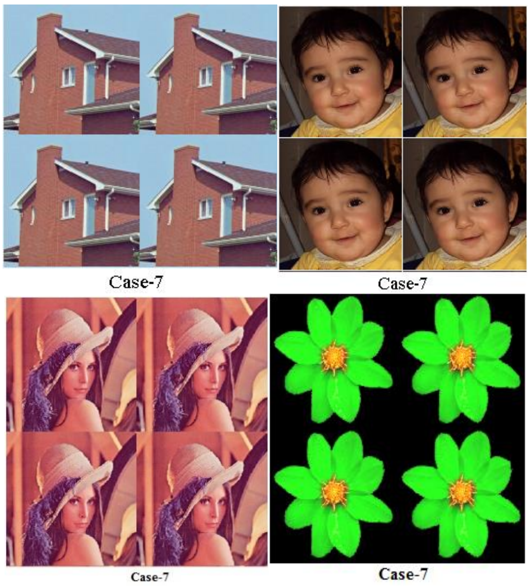
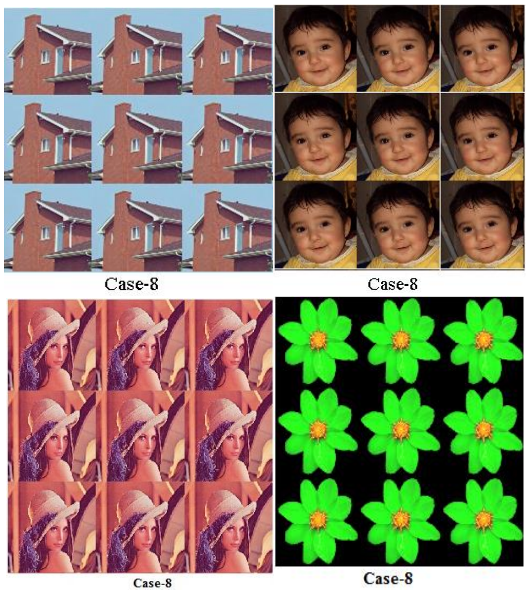


Table 9. Case-8.

Case number	Image	MSE	SNR	PSNR
Case (8)	House	252.5775	85.8961	24.1069
	BabyFace	**111.3289**	**79.9093**	**27.6647**
	Lena	**27.2975**	22.5124	**24.3087**
	Flower	**7.5091**	**969.7663**	**13.5039**



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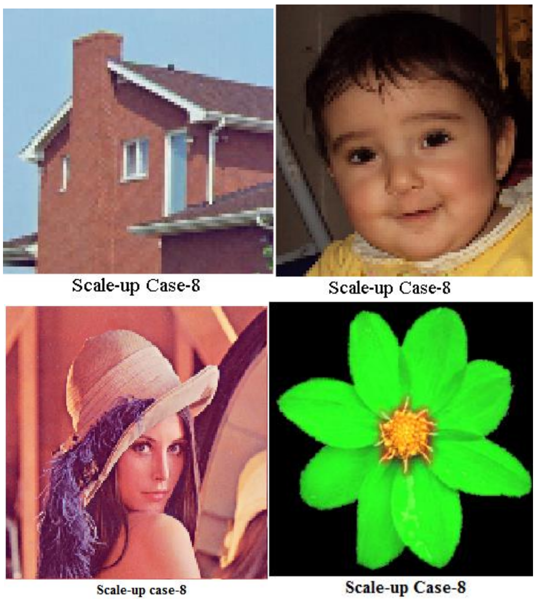
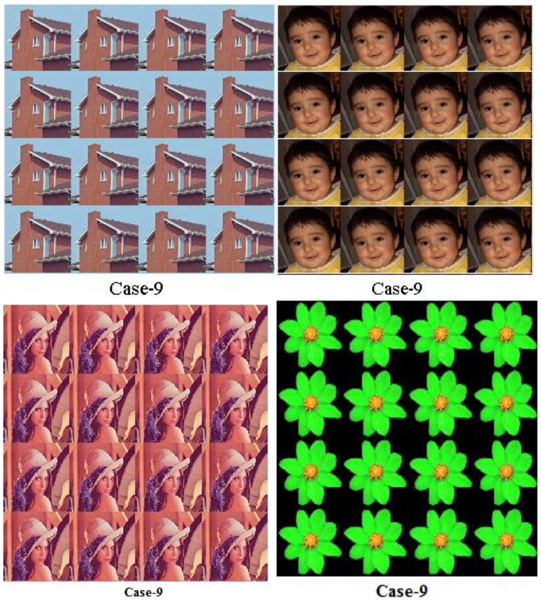
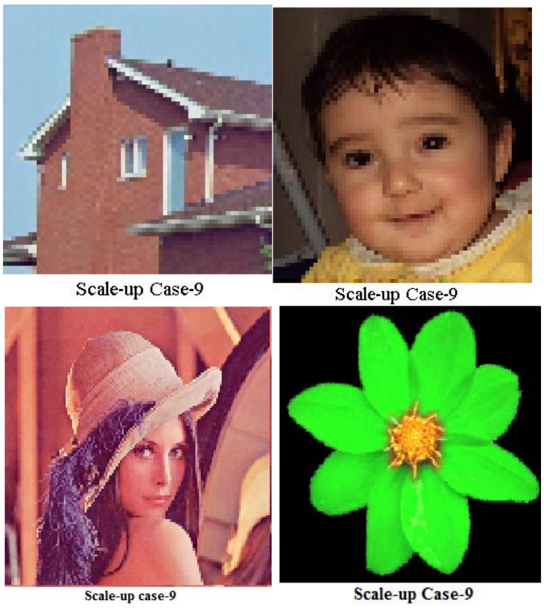


Table 10. Case-9.

Case number	Image	MSE	SNR	PSNR
Case (9)	House	229.3782	94.5837	24.5253
	BabyFace	408.9269	21.7550	22.0144
	Lena	34.5488	15.0615	22.0465
	Flower	9.8984	522.8545	13.4293





The results of the proposed algorithm in addition to the experimental results were compared with the results of the scaling algorithm in [17] by using Lena digital image. The experimental results of enlarging Lena image that reduced previously according to algorithm in [17] are (**23.011** and **25.351**) for MSE and PSNR respectively. The experimental results of reducing Lena image that enlarged previously according to algorithm in [17] are (**24.611** and **35.421**) for **MSE** and **PSNR** respectively. The best results of Lena image in the proposed algorithm is (**27.2975** and **24.3087**) for **MSE** and **PSNR** respectively. The comparison results show that the the proposed algorithm has very near results with algorithm in [17] that is prove the effectiveness of the proposed algorithm.

The proposed approach works perfect with even numbers of control points but increasing the scaling factor and the value of t will reduce the resolution of the reconstructed (scaled-up) image. When the numbers of control points are odd some of the scaled-down and scaled-up images have lost. The resolution of reconstructed images with odd control points will also decrease by increasing the scaling factor and the value of t. These problems can be solved as a suggestion to the future works.

Conclusion

Image resizing (scaling-up and scaling-down) used with many image processing applications and digital devices. The important issue with image scaling is how to maintain the image information without losing the visual content. This paper proposes a digital image scaling (up and down) by using Bezier curve equations. The experiments show the results of scaling image by changing different parameters. The proposed method produces a good result according to the experimental results and the best results found

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by applying the Bezier curve with even number of the control points. The proposed algorithm has also compared with another new scaling algorithm and improves its effectiveness. The experimental results show that the digital image can be scaling down and scaling up and retrieve to original by using Bezier curve equation and scaling factor without losing the visual content.

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Authors' Declaration

- Conflicts of Interest: None.
- We hereby confirm that all the Figures and Tables in the manuscript are ours. Furthermore, any Figures and images, that are not ours, have been included with the necessary permission for re-publication, which is attached to the manuscript.
- Ethical Clearance: The project was approved by the local ethical committee in University of Baghdad.
- Ethics statement:
  No animal studies are present in the manuscript.
  No human studies are present in the manuscript.
  No potentially identified images or data are present in the manuscript.

References

1. Maria P, Costas P. Image Processing. The Fundamentals. John Wiley and Sons Ltd publications. 2010; 2nd Ed: 1-3. Singapore.
2. Rafael C, Richard E. Digital Image Processing. Pearson Education. 2018; 4th Ed: 17-32. Malaysia.
3. Safinaz S. An Efficient Algorithm for Image Scaling with High Boost Filtering. Int J Sci Res. 2014; 4(5): 1-9.
4. Wardah A, Khurram K, Asfaq A. Optimized Image Scaling Using DWT and Different Interpolation Techniques. Int J Adv Comput Sci Appl. 2016; 7(6): 294-300. https://doi.org/10.14569/IJACSA.2016.070638.
5. Abdulameer A, AbdulMohsin J, Haider M. Image Steganography System Using Bezier Curve. Mans J. 2019; 31: 111-133.
6. Bharath S, Ashish K , Magudeeswaran V. Optimal Bezier Curve Modification Function for Contrast Degraded Images. IEEE Trans Instrum Meas. 2021; 70: 1-10. https://doi.org/10.1109/TIM.2021.3073320
7. Khurshid A, Ghulam G, Mubbashar S, Zulfiqar H. Automatic Enhancement of Digital Images Using Cubic Bezier Curve and Fourier Transformation. Malays J Comput Sci. 2017; 30(4): 300-310. https://doi.org/10.22452/mjcs.vol30no4.3.
8. 8. Qing'an C, Yichi Z. Optimization of parameters for FDM process with functional input based on LSSVR. AIP Adv. 2022; 12(2): 02510810- 02510811. https://doi.org/10.1063/5.0079759.
9. Magudeeswaran V, Ashish K, Bharath S. Optimized Bezier Curve Based Intensity Mapping Scheme for Low Light Image Enhancement. IEEE Trans Emerg Top Comput Intell. 2021; 6(3): 602-612. https://doi.org/10.1109/TETCI.2021.3053253.
10. Yuliang L, Hao C, Chunhua S, Tong H, Lianwen J, Liangwei W. ABCNet: Real-time Scene Text Spotting with Adaptive Bezier-Curve Network. IEEE Conf Comput Vis Pattern Recogn. 2020; 2: 9806-9815. https://doi.org/10.1109/CVPR42600.2020.00983.
11. Previste M. Using Bezier Curve analysis in context of Expression Analysis. E-prints Lib Inf Sci Conf. 2020.
12. Paulo H, Thiago F, Jorge V, Helio P, Rui B. Reconstruction of Panoramic Dental Images Through Bézier Function Optimization. Front Bioeng Biotechnol. 2020; 8:1-8. https://doi.org/10.3389/fbioe.2020.00794.
13. Haichou C, Yishu D, Bin L, Zeqin L, Haohua C, Bingzhong J, et al. BezierSeg: Parametric Shape Representation for Fast Object Segmentation in Medical Images. Elsevier. 2021; 13(3): 1-9. https://doi.org/10.48550/arXiv.2108.00760.
14. Hong-Seng G, Tan T, Ahmad H, Khairil A, Mohammed R, Weng-Kit T, et al. Medical Image Visual Appearance Improvement Using Bihistogram Bezier Curve Contrast Enhancement: Data from the Osteoarthritis Initiative. Sci World J. 2014: 1-13. https://doi.org/10.1155/2014/294104.
15. H. Abdel-Aziz, E. Zanaty, Haytham A, M. Saad. Generating B´ezier Curves for Medical Image Reconstruction. Elsevier. Res Phys. 2021; 23: 103996. https://doi.org/10.1016/j.rinp.2021.103996.
16. Khalid K, Daya KL. Generalized Bézier Curves and their Applications in Computer Aided Geometric

Design. PhD thesis. New Delhi. 2018: 3-33; https://doi.org/10.13140/RG.2.2.28551.04001.
17. Jiangang J. An Adaptive Image Scaling Algorithm Based on Continuous fraction Interpolation and Multi Resolution Hierarchy Processing. World Sci Fractals. 2020; 28(8): 1-13. https://doi.org/10.1142/S0218348X20400162.
18. Karthick R, Manoj P, Selvaprasanth P, Sathiyanathan N, Nagaraj A. High Resolution Image Scaling Using Fuzzy Based FPGA Implementation. Asian J Appl Sci Technol. 2019; 3(1): 215-221. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3353627.
19. Juncheng L, Lian Y, Yuee Z. Image Scaling Based on the Catmull-Rom Spline Surfaces with Free Parameters. 3rd Int Conf Model Simul Appl Math. 2018. https://doi.org/10.2991/msam-18.2018.66.
20. Antonios G, I. Andreadis, A. Gasteratos. A Log-Polar Interpolation Applied to Image Scaling. IEEE Int Work Imag Sys Tech. 2007; 1-5. https://doi.org/10.1109/IST.2007.379610.
21. Samuel R. 3D Computer Graphics a Mathematical Introduction with OpenGL. Revision Draft A.10.b, 2nd Edition. 2019: 237-255.
22. Zabidi A, Zainor R, Nur A, Nurshazneem R. Curve Reconstruction in Different Cubic Functions Using Differential Evolution. MATEC Web Conf. 2018; 150: 1-6. https://doi.org/10.1051/matecconf/201815006030.
23. Alyn P, Peter C, Hans H. Introduction to Curves and Surfaces. Siggraph. 1996; 1st Ed: 33-52.
24. Senay B, Bulent K. Defining a curve as a Bezier curve. J Taibah Univ Sci. 2019; 13(1): 522-528. https://doi.org/10.1080/16583655.2019.1601913.
25. Sambhunath B, Brian C. Bezier and Splines in Image Processing and Machine Vision. Springer-Verlag London Limited. 2008. https://doi.org/10.1007/978-1-84628-957-6.
26. Heewon K, Myungsub C, Bee L, Kyoung M. Task-Aware Image Downscaling. Eur Conf Comput Vis. 2018; 419-434. https://doi.org/10.1007/978-3-030-01225-0_25.
27. Osamah I, Carlos A, A. Azhagu J, G. Vinuja. VLSI Implementation of a High Performance Nonlinear Image Scaling Algorithm. J Healthc Eng. 2021; 5: 1-10. https://doi.org/10.1155/2021/6297856.
28. Sudip K, Neelesh A, Arvind K, Navendu N, Mukesh K. Performance Analysis of Different Interpolation Technique Used for Improving PSNR of Different Images Using Wavelet Transform. Int J Eng Res Technol. 2013; 2(6): 1367-1372.
29. Qassim S, Ali NF, Anwar H, Alden N. Image Compression Based on Lossless Wavelet With Hybeid 2D-Decomposiyion. Diyala J Eng Sci. 2012; 5(1):1-12. https://doi.org/10.24237/djes.2012.05101.
30. Sumathi P, G.Ravindran. The Performance of Fractal Image Compression on Different Imaging Modalities Using Objective Quality Measures. Int J Eng Sci Technol. 2011; 3(1): 525-530. http://www.ijest.info/docs/IJEST11-03-01-007.pdf. https://doi.org/10.17577/IJERTV2IS60491
31. Enas TK, Ekhlas FN, Alaa NM. Comparison between RSA and CAST-128 with Adaptive Key for Video Frames Encryption with Highest Average Entropy. Baghdad Sci J. 2022; 19(6): 1378-1386, https://doi.org/10.21123/bsj.2022.6398.
32. Basma JS, Ahmed YF, Ali TQ, Lamees A. Optimum Median Filter Based on Crow Optimization Algorithm. Baghdad Sci J. 2021; 18(3): 614-627, https://doi.org/10.21123/bsj.2021.18.3.0614.

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طريقة مقترحة لتغيير حجم الصورة باستخدام منحني Bezier

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قسم الحاسوب، كلية العلوم، جامعة بغداد، بغداد، العراق.

الخلاصة

عملية تغيير حجم الصورة في مجال معالجة الصور باستخدام التحويلات الهندسية بدون تغيير دقة الصورة تعرف ب image scaling او image resizing. عملية تغيير حجم الصورة لها تطبيقات واسعة في مجال الحاسوب والهاتف النقال والاجهزة الالكترونية الاخرى. يقترح هذا البحث طريقة لتغيير حجم الصورة باستخدام المعادلات الخاصة بمنحني Bezier وكيفية الحصول على افضل نتائج. تم استخدام Bezier curve في اعمال سابقة في مجالات مختلفة ولكن في هذا البحث تم استخدام معادلات ال Bezier curve في تغيير حجم الصور. فكرة استخدام معدلات Bezier curve في تغيير حجم الصور تاتي من خاصية توليد النقاط التي تقع على المنحني والتي تعمل على سحب احداثيات النقاط الموجودة في الصورة بالاعتماد على شكل المنحني وبالتالي تغيير حجم الصورة. تتميز هذه الخوارزمية بسرعة الاداء في تغيير حجم الصور لذلك فهي مفيدة في مجال معالجة الصور والتطبيقات الواقعية التي تحتاج الى تغيير حجم الصور بسرعة هائلة. تم اختبار دقة الخوارزمية باستخدام مقاييس MSE و SNR و PSNR حيث تم تطبيق المقاييس على الصور الاصلية و الصور المسترجعة من عملية تغيير حجم الصورة وكانت النتائج مقبولة كطريقة مقترحة وسريعة لتغيير حجم الصور. وتم استنتاج ان الخوارزمية تعطي افضل النتائج في تصغير او تكبير الصور عندما تكون عدد النقاط المستخدمة في توليد المنحني زوجية اما اذا كانت عدد النقاط فردية فسوف يكون هنالك ضياع في جزء من الصورة الذي يعتمد على معامل التغيير.

الكلمات المفتاحية: منحني Bezier، تغيير حجم الصورة، التكبير، التصغير، معامل تغيير الحجم.