Enhancement of the Enlargement of Images

Tara Naughton

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Abstract

Methods typically used to enlarge images - pixel replication and interpolation - either produce images too jagged or too blurred. The intent of this project is to develop a method for enlarging images that retains the sharpness of edges while still keeping an image that looks smooth and high quality. The focus is on building off of the interpolation method by detecting edge pixels and deriving an equation to appropriately adjust their intensity in the enlarged images.

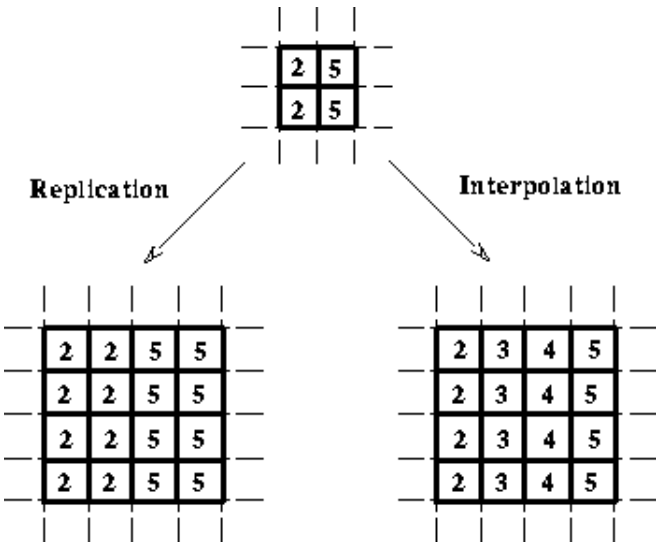

Figure 1: Pixel replication vs. interpolation

1 Introduction

In image processing, two different methods of image enlargement are most commonly used: pixel replication - which simply repeats each pixel value for the amount of the scale factor - and interpolation - which constructs new data points between two pixels that work as a gradient connecting one pixel to another in the enlarged image. Unfortunately, both methods tend to produce less than desirable results; images resized with the pixel replication method often look very jagged and overly pixelated, while on the other hand, images resized with the interpolation method come out too blurry and with undefined edges. This project aims to find an algorithm that produces high quality enlarged images that can both preserve sharpness and avoid producing an overly pixelated image.

2 Similar Research

This project is not the first to call attention to the inadequacies of the common types of image enlargement; several research projects have been done in the past to develop algorithms to produce enlarged images that are both sharp and continuous. One method explored was enlargement with use of a step edge model. With this algorithm, edge pixels were located, ramp parameters were derived from those pixels, and intensity values were derived from those parameters. Those parameters are then kept and applied to the larger image.

Another method that has been worked on involves a step edge model. The image is divided into atomic areas, and step edge parameters are derived for each pixel. An intensity is found for each atomic area. Additionally, a step-likeness value is found to see if the area is actually near a step-edge. That step-likeness value is then used as weight to combine the intensity values for that atomic area.

While many of the algorithms that have been developed utilize different methods, many of them focus on treating edges separately from the rest of the image and preserving their sharpness. Edge detection methods are often used after interpolating an image,

3 Development

The code for the project is written in Python. The algorithm takes a black-and-white .pgm image as input, call on a edge detection method and interpolation method that will be written separately and then called upon in a separate part of the code, and produce a .pgm image that is a resized version of the original. The interpolation method resizes non-edges adequately, so it is only necessary to single out the edges and resize them independently in order to preserve the sharpness of the image. To test the program, images produced by the algorithm will be compared to the same resized image of the same scale produced by the two traditional methods (pixel replication and interpolation) and overall image quality will be evaluated.

4 Results

At the moment, the pixel replication and interpolation methods have been completed. Additionally, a sobel edge detection method has been completed, which includes a method that derives the edge values of certain pixels using the values of neighboring pixels and a horizontal and vertical gradient mask.

Horizontal gradient G_x mask:

-1	0	1
-2	0	2
-1	0	1

Vertical gradient G_y mask:

1	2	1
0	0	0
-1	-2	-1

$$G = |G_x| + |G_y|$$

Figure 2: G-value masks and equation

An equation to derive intensity values for resized pixels based on this edge value is currently being developed.

5 Discussion

In this stage, I plan to spend much of the quarter experimenting and deriving an equation for adjusting intensity values that optimizes image quality. I have started work on this, but the equations I have worked with so far have been unsatisfactory, either making the image look discontinuous or not showing enough of a difference from the typical interpolation method. I am considering adjusting the equation to work with more variables than just edge value. In the grand scheme of things, I will still be working to make the image as sharp as possible while still remaining continuous. If there is enough time, I will also take measures to eliminate noise that was present in the original image in the enhanced image. As image quality is not something where you can reach a definitive stopping point in research like this, I plan to continue developing and improving this method until the end of the year, and create a functioning algorithm that can even be built off of in future research.

References

[1] Jia-Guu Leu, "Image enlargement based on a step edge model", *Pattern Recognition*, pp. 2055-2073, 2005.

[2] Jia-Guu Leu, "Image enlargement based on a ramp edge model", *Pattern Recognition*, pp. 1927-1938, 2001.

[3] Fisher, R., et al., "Geometric Scaling", 2003. http://homepages.inf.ed.ac.uk/rbf/HIPR2/scale.htm (October 30, 2009)

Figure 3: Original image

Figure 4: Image resized by pixel replication

Figure 5: Image resized by interpolation