Analysis and comparison of image interpolation techniques

Digital Signal Analysis and Application - Project

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***Abstract*—Image Interpolation is an important problem in the field of Signal Processing and Computer Vision. It has practical applications in a lot of fields, including but not limited to Graphics Design, Social Media, Gaming etc.**

***Keywords*—Image Interpolation, Zooming**

I. Introduction

Image Interpolation is the process of enlarging a bitmap image, while attempting to conserve the visual characteristics of the original image. Image interpolation finds many applications in the fields of Graphics Design, Social Media, Game Design etc. This problem is not present in vector graphics, since they are inherently scalable to any dimension. Various methods for interpolation of images have been proposed, varying in the quality of the result (including possible artifacts) and the amount of computation required. Here, we pick a few of these algorithms and evaluate their output against each other.

II. Algorithms

These algorithms can be divided broadly into two classes:

1. **Non-adaptive algorithms** – These algorithms treat all pixels equally and affect all regions of an image in the same way.

2. **Adaptive algorithms** – These are algorithms of considerably higher complexity, and change depending on the type of object they are interpolating (sharp edges vs smooth texture). Many of these algorithms are proprietary in nature, and we choose not to cover them in our project.

Some of the algorithms in the former category are:

- **Bilinear Interpolation** – This method considers a 2x2 neighborhood of known pixel values surrounding the unknown pixel. A weighted average of these four pixels is calculated to arrive at its final interpolated value.
- **Bicubic Interpolation** – Bicubic goes one step beyond bilinear by considering 4x4 neighborhood of known pixels, thus increasing the count of the pixels considered to 16. Since some of these pixels are closer to the unknown pixel than others, these are given more weighting. A noticeably sharp image is produced as an output, which causes it to strike an ideal balance between computational load and output quality. For this reason, this algorithm is standard in many editing programs including Adobe Photoshop.
- **Spline Interpolation** – This takes much more surrounding pixels into consideration while computing the unknown pixel, thus increasing both the computational load and quality. Higher order functions such as this provide diminishing visual improvements compared with the increase in processing time.
- **FFT based interpolation** – This method uses *zero padding in frequency domain*, i.e. padding of the signal with zeroes in the frequency domain, and computing the inverse Fourier Transform to obtain the interpolated image.

III. Data Preparation and Results

Since no Machine Learning algorithms are being used, datasets is not a big issue. Standard royalty-free images, obtained using various image libraries available online will be used. These images will be downscaled, and the output from these algorithms will be compared with the original image.

We will try to compare and evaluate some of these algorithms based on visual quality, computation intensiveness, and artifacts, if any.

IV. Results

Various algorithms for image extrapolation have been proposed. We take a look at one class of these – Non Adaptive Algorithms, and compare their results. Higher order algorithms provide decreasing improvements in visual quality while incurring a significant additional computational load.