Homework # 1

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**Exercise 1**

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|  | Original | Bilinear | Bicubic |
| Image | 一張含有 人員, 人的臉孔, 嘴唇, 自拍 的圖片  自動產生的描述 | 一張含有 人員, 人的臉孔, 嘴唇, 皮膚 的圖片  自動產生的描述 | 一張含有 人員, 人的臉孔, 嘴唇, 皮膚 的圖片  自動產生的描述 |
| size | 1125\*1125 | 945\*945 | 945\*945 |
| MSE |  | 10.663137 | 10.597258 |
| PSNR |  | 35.109027 | 35.186628 |
| SSIM |  | 0.941024 | 0.938731 |

一張含有 文字, 字型, 螢幕擷取畫面, 印刷術 的圖片

自動產生的描述

3.

**Bilinear** interpolation works by doing linear interpolation along both the X and Y axes. It interpolates in one direction first, then in the other to get the final pixel value. Since it only uses the 4 nearest pixels to calculate a new on, it’s pretty simple.

However, **Bicubic** interpolation is more complex --- it uses cubic polynomials to get it done. Considering the brightness changes of neighboring pixels, which helps maintain more details and sharper edges.

In short, bilinear interpolation is simpler and faster, but it tends to lose detail and can make images blurry; On the other hand, bicubic interpolation is more complex but does a better job of preserving details and edges, giving a higher image quality overall. That’s why we can see that no matter in MSE, PSNR or SSIM, bicubic interpolation has a better performance from the comparison above.

1. A more detailed operation on **Bicubic** interpolation:
2. **Grid Selection**:   
   It uses a 4x4 grid of pixels around the pixel being interpolated. This means it uses the 16 nearest pixel values to calculate the new pixel.
3. **Cubic Interpolation**:

First, interpolation is done along one axis. The pixel values in the 4 nearest columns are interpolated using cubic polynomials. The process is repeated along the Y-axis. After calculating interpolated values along the X-axis, the same interpolation is done along the Y-axis, using the results from the X-interpolation.

1. **Cubic Polynomial**:

The interpolation is based on a cubic function ,which a,b,c,d are determined using the four neighboring pixel values.

1. **Weighted Average:**   
   The final interpolated pixel value is computed as a weighted average of the 16 surrounding pixels, with the weights determined by the cubic polynomial.
2. Computational Complexity Comparison

Even though both Bilinear and Bicubic interpolation have the same complexity of O(n\*m), where n\*m represents the number of pixel in the image, Bicubic interpolation is slower. This is because it works with a larger constant factor (16 neighboring pixels and performs cubic interpolation).