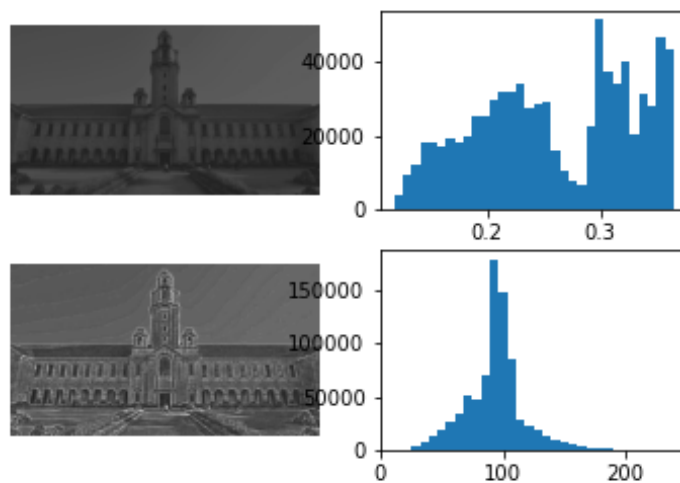


DIP Assignment 2 Results

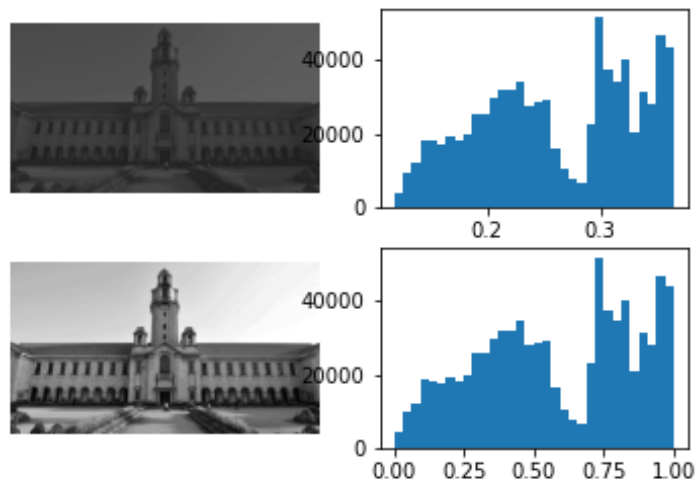
Q1. NOTE: CLAHE with overlapping is not implemented in this question

The histogram plots and images after contrast enhancement for each of the images IIScMainBuilding_LowContrast.png, LowLight_2.png, LowLight_3.png, Hazy.png, StoneFace.png are as follows:

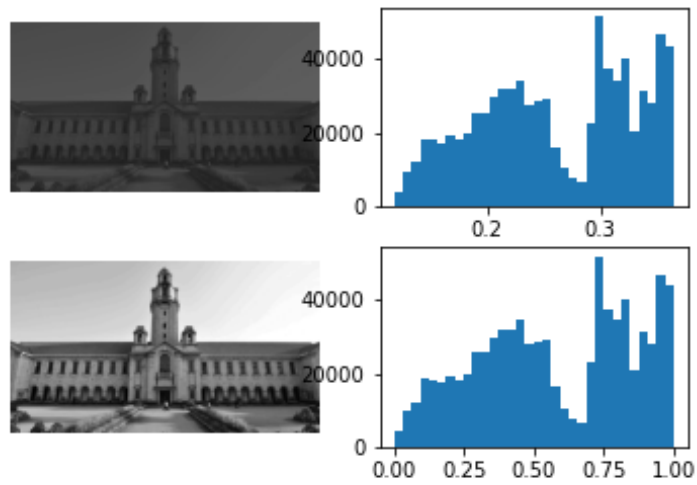
CLAHE - No Overlap



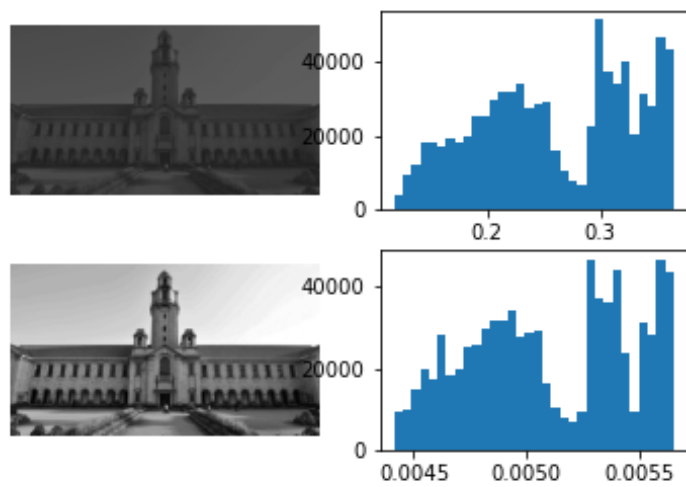
Full Scale Contrast Stretch



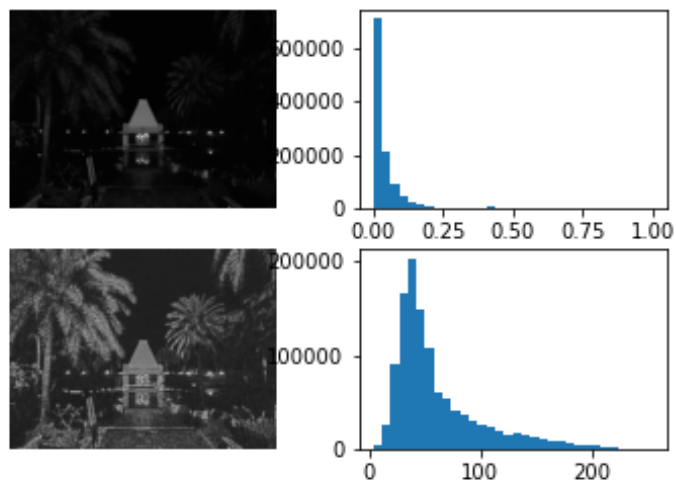
Histogram Equalization with Full Scale Contrast Stretch



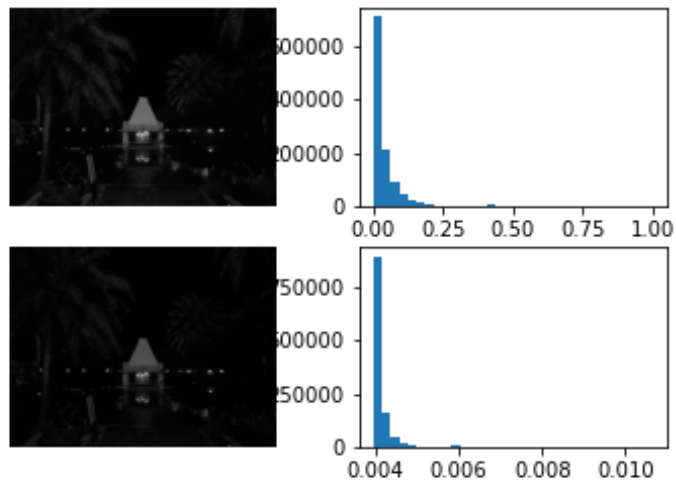
Non-linear Contrast Stretch



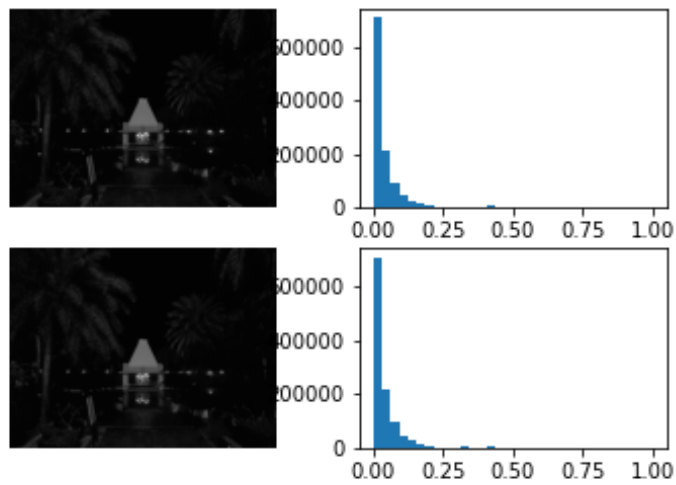
CLAHE - No Overlap



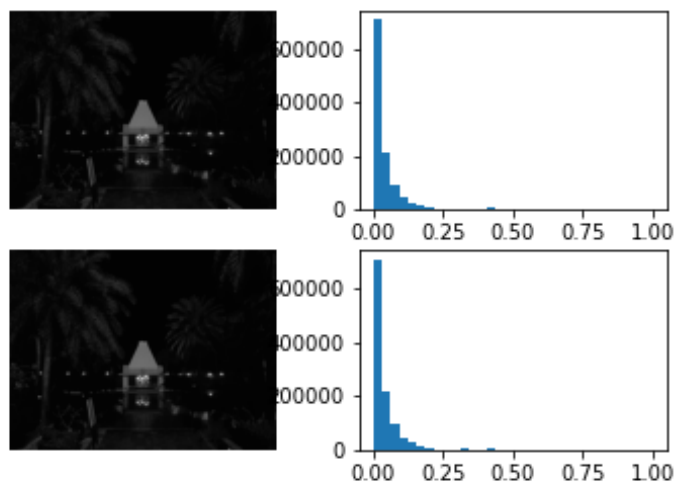
Non-linear Contrast Stretch



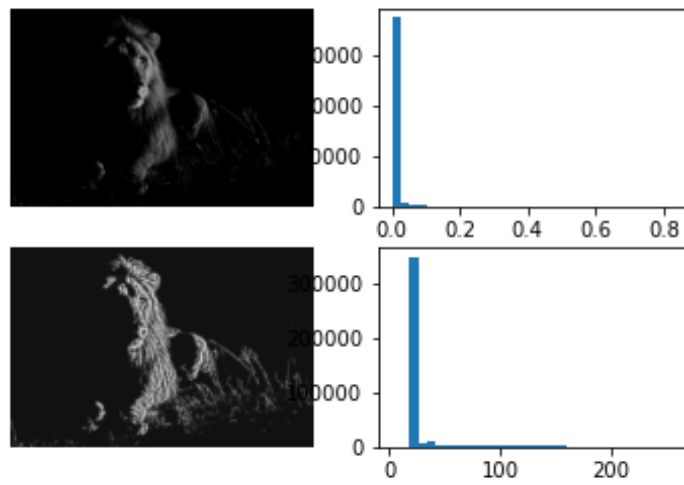
Histogram Equalization with Full Scale Contrast Stretch



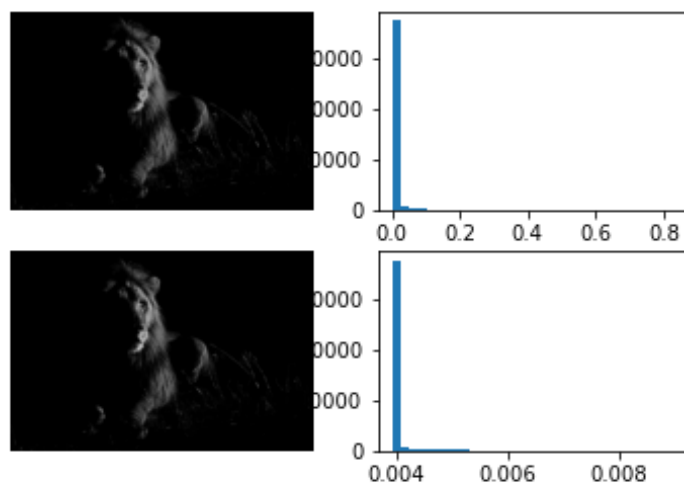
Full Scale Contrast Stretch



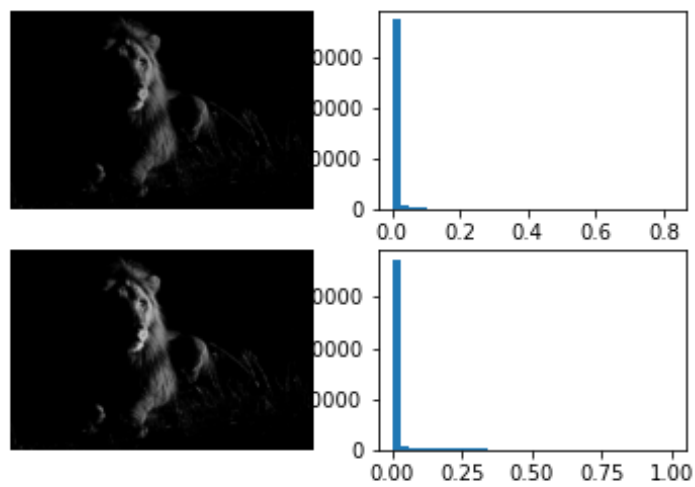
CLAHE - No Overlap



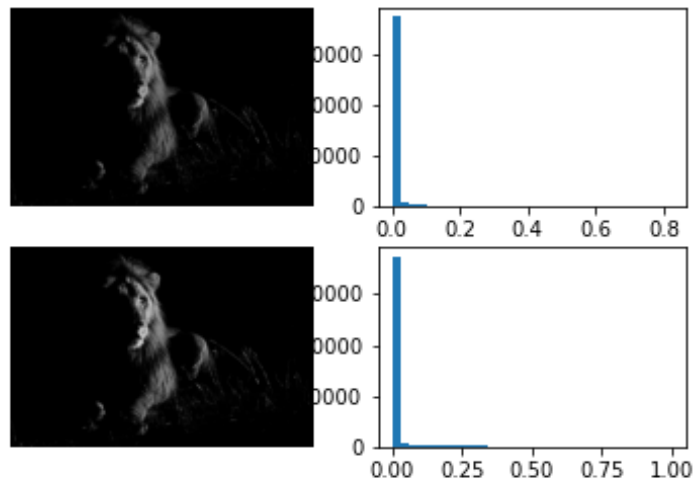
Non-linear Contrast Stretch



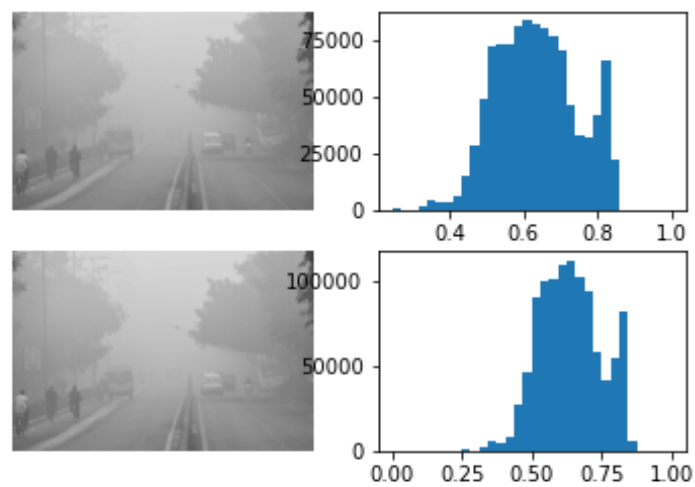
Full Scale Contrast Stretch



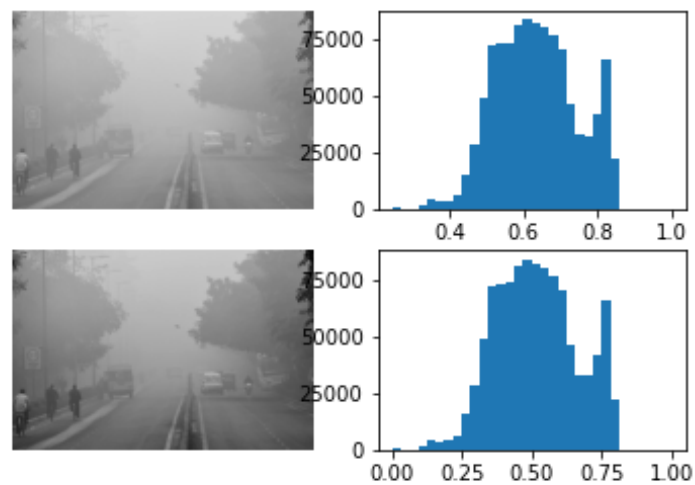
Histogram Equalization with Full Scale Contrast Stretch



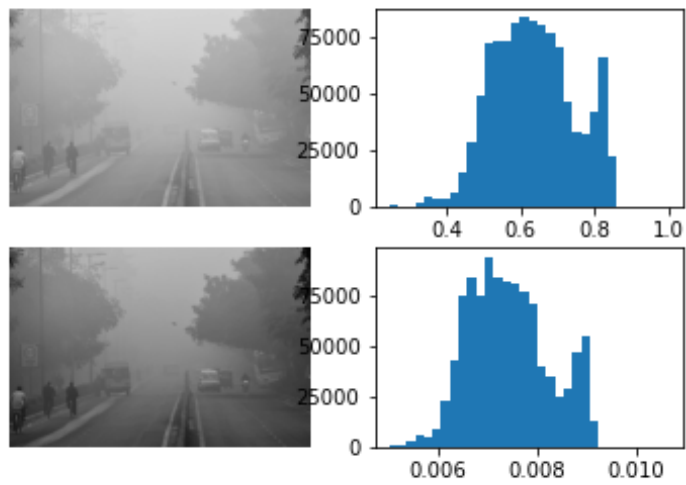
Histogram Equalization with Full Scale Contrast Stretch



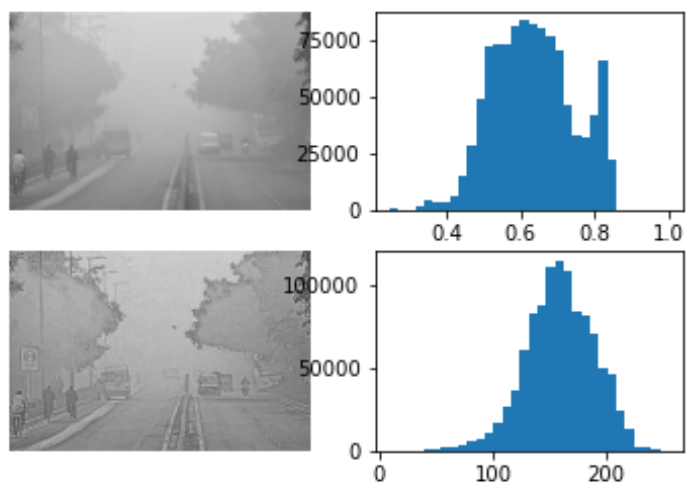
Full Scale Contrast Stretch



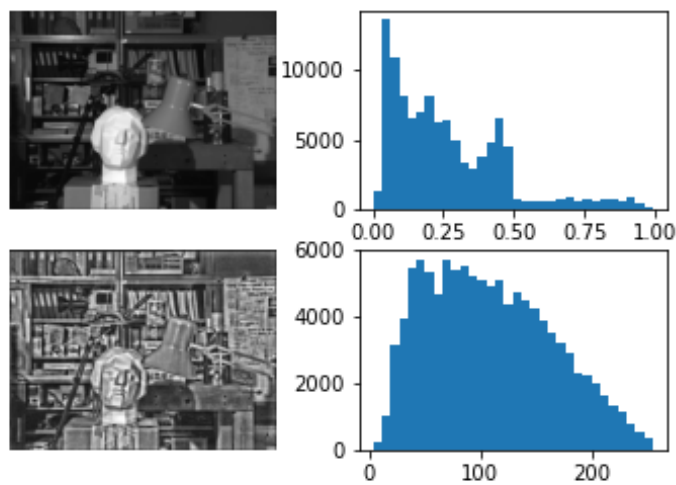
Non-linear Contrast Stretch



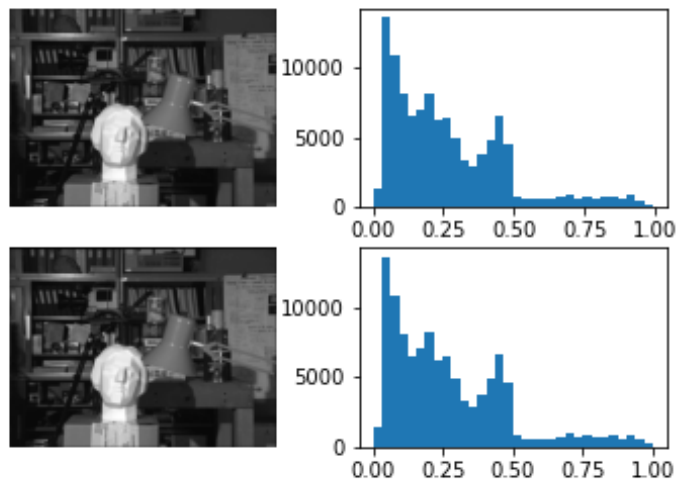
CLAHE - No Overlap



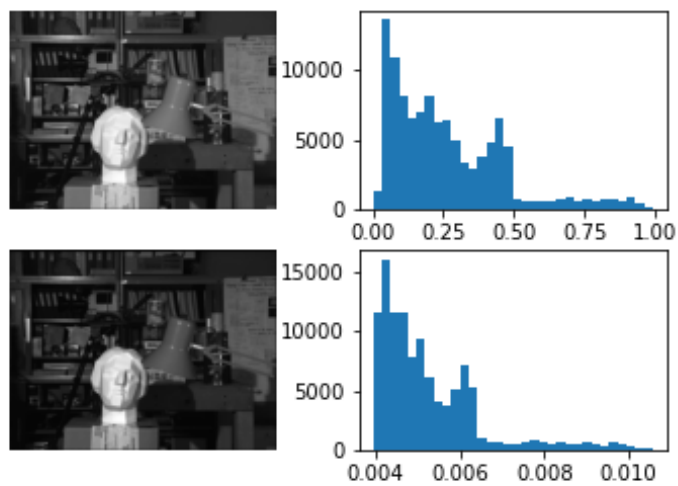
CLAHE - No Overlap



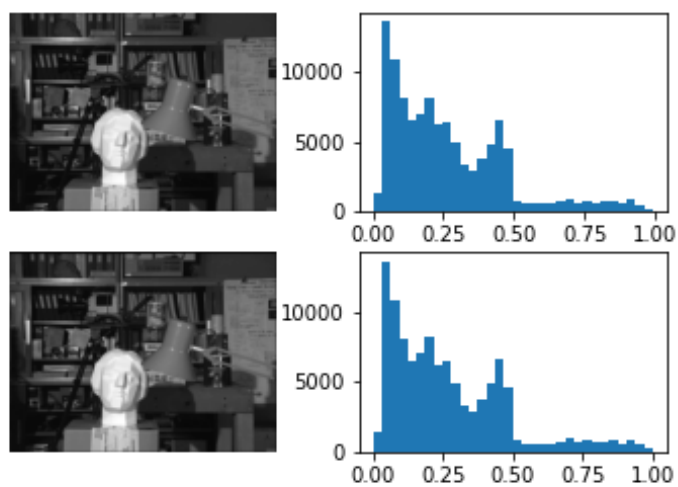
Histogram Equalization with Full Scale Contrast Stretch



Non-linear Contrast Stretch

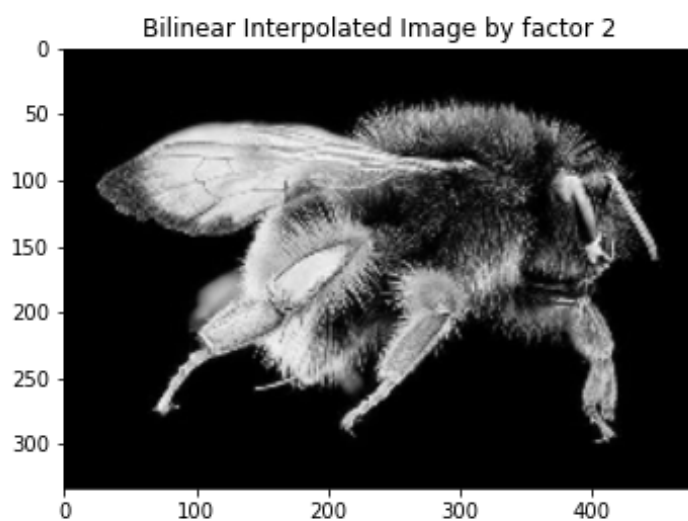
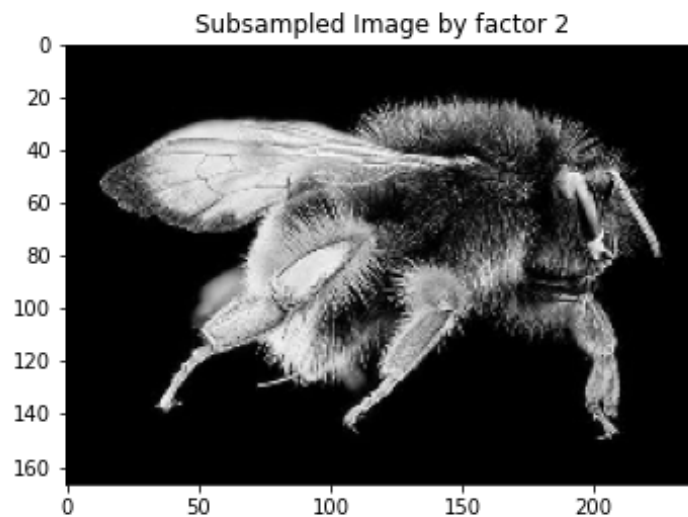
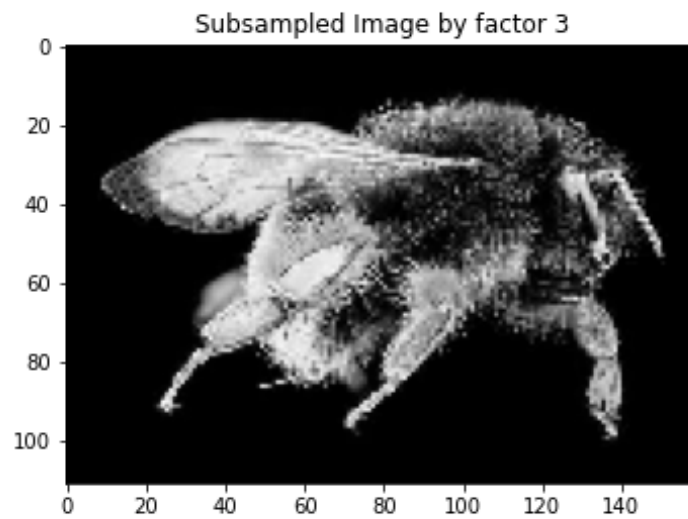


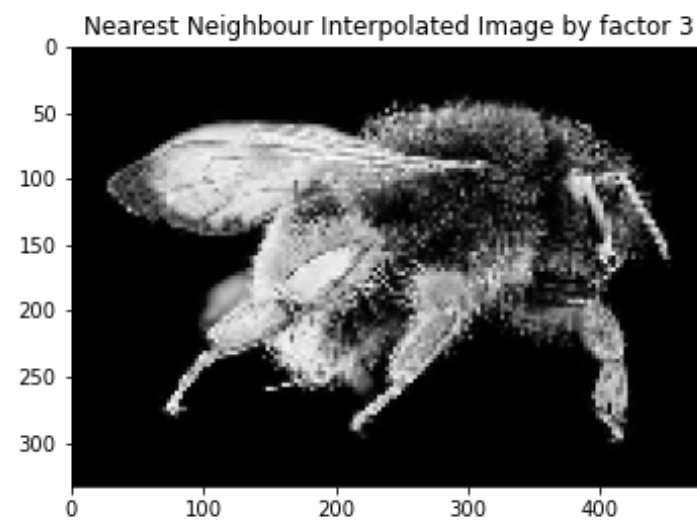
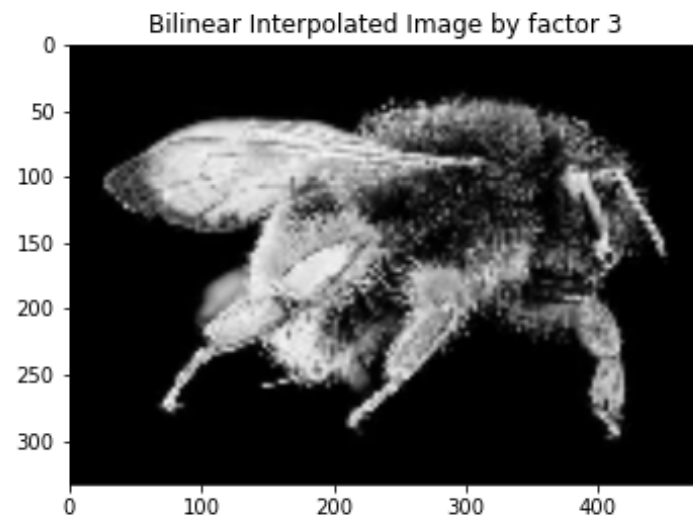
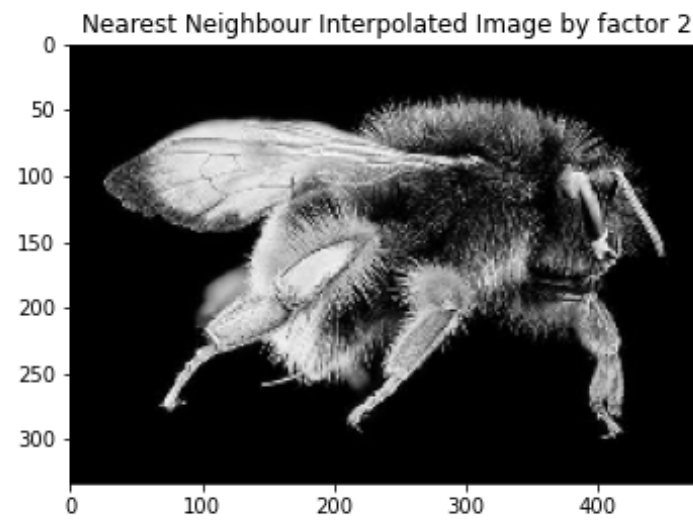
Full Scale Contrast Stretch

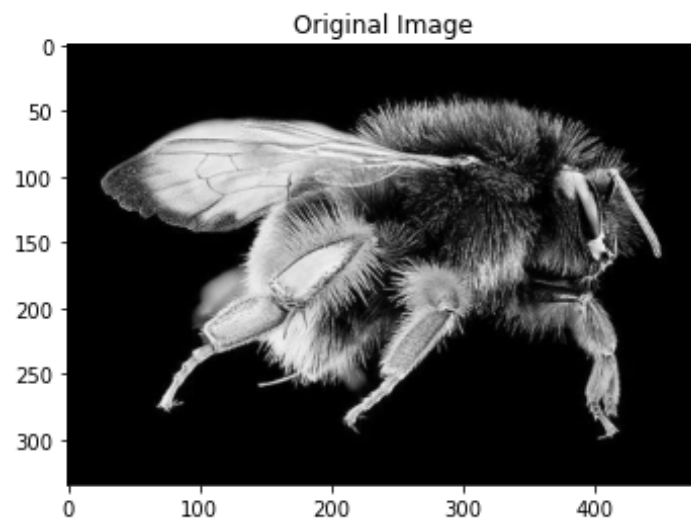


- IIScMainBuilding_LowContrast.png:
 - For IIScMainBuilding_LowContrast.png, all four algorithms succeeded. In the case of CLAHE, if we increase the window size to 32 and keep the clip limit to 8 then we get a better-enhanced image than the one with 8 window size and 10 clip limit.
 - The reason almost all algorithms succeeded for this image is that this image already has a better contrast compared to other images. So, the contrast can be fixed with simple algorithms as well.
- LowLight_2.png:
 - For LowLight_2.png, CLAHE without overlapping performs better than all other 3 algorithms. The reason is in this image, all the pixels are saturated at lower pixel intensity values. CLAHE is used to improve the contrast of such images specifically. The only issue is that the contrast-enhanced image has some noise which can further be reduced with CLAHE using overlapped windows.
- LowLight_3.png:
 - For LowLight_3.png as well, CLAHE without overlapping performs better. This image in fact has more saturation of pixels to lower intensities. So, to get better contrast CLAHE is a must.
- Hazy.png:
 - Hazy.png is the opposite of LowLight_2.png i.e. most of the pixels are saturated at higher intensity values. For such kinds of images, CLAHE with overlapping will perform better. If we increase the window size to 32 and keep the clip limit to 8 then we get better contrast but with some noise.
- StoneFace.png:
 - In the case of StoneFace.png, all algorithms give acceptable outputs. But if we look at the face of stone then it is much more clear if we use CLAHE. The reason is in the face region, the contrast of the image is low so CLAHE tends to perform better there.

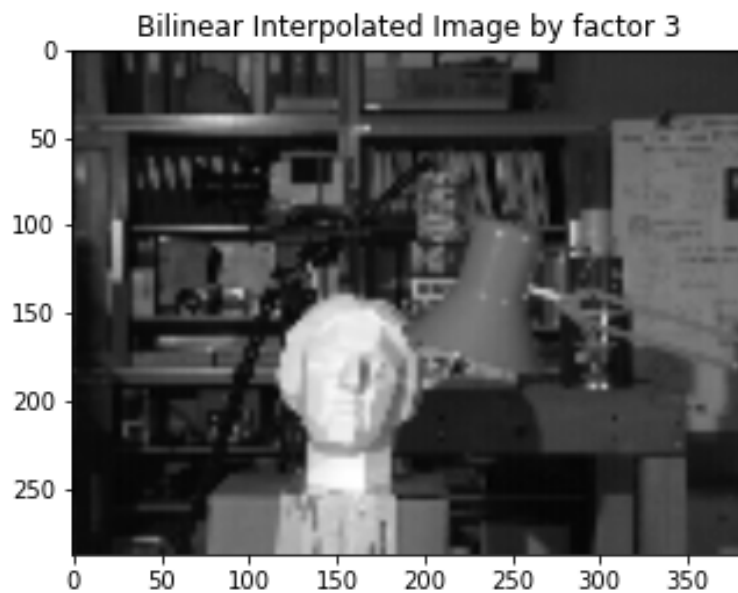
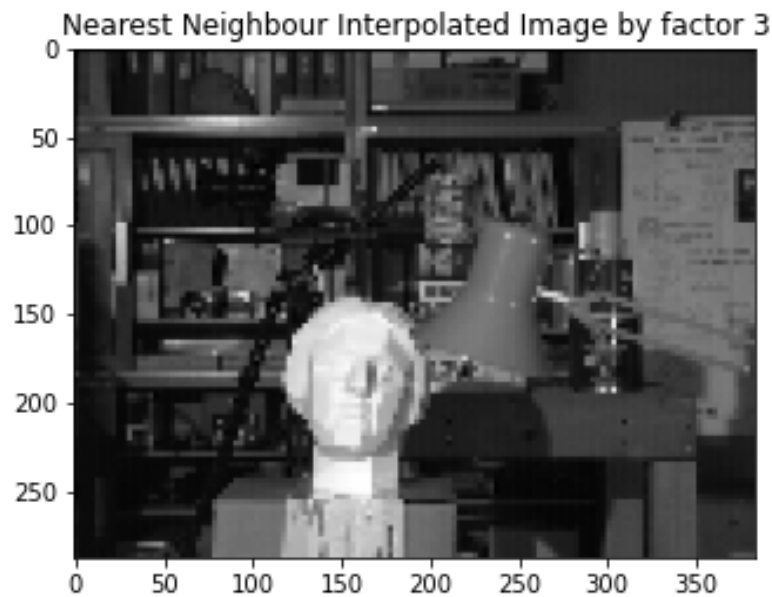
Q2. Bee.jpg subsampled, upsampled images by factors 2 and 3 using corresponding interpolation methods:

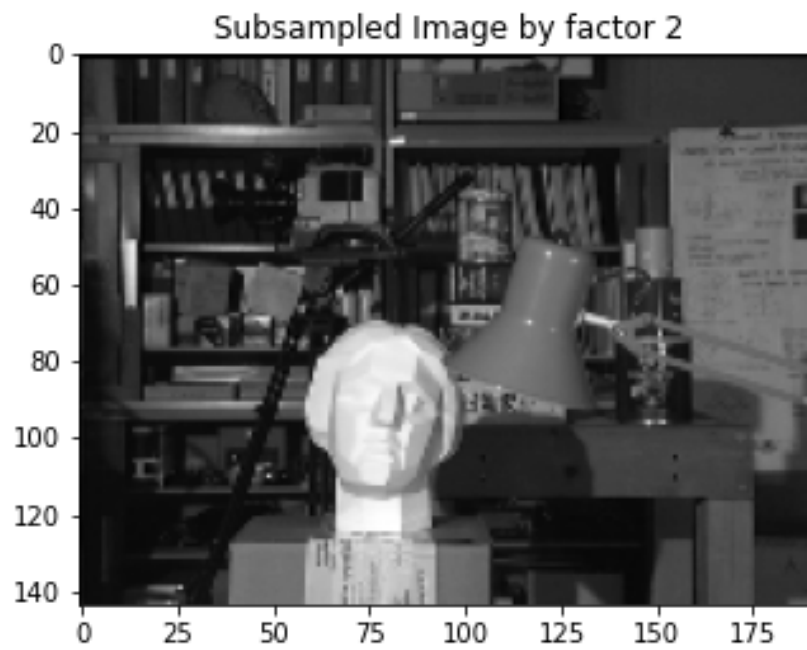
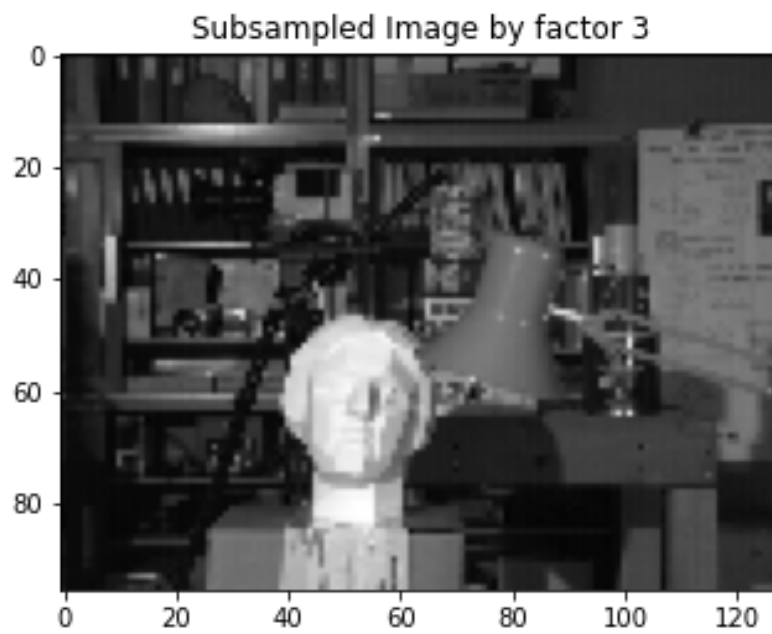




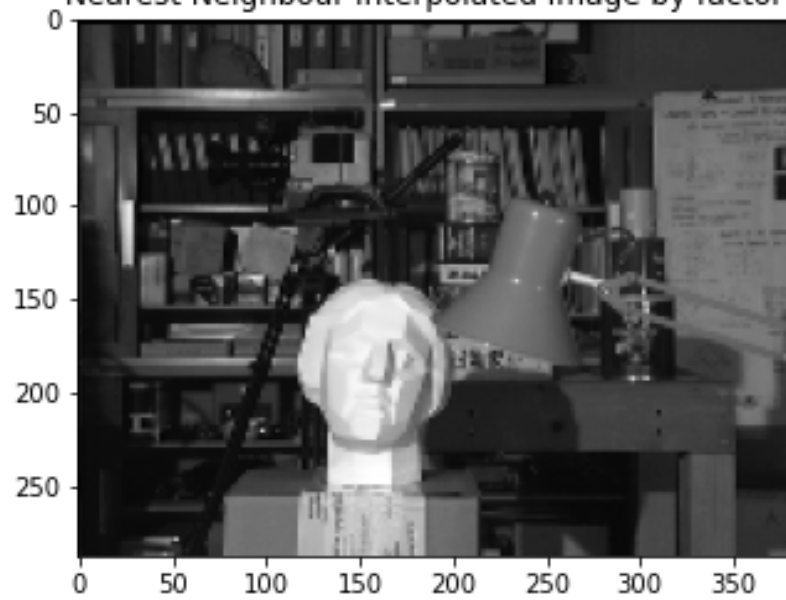


StoneFace.png subsampled, upsampled images by factors 2 and 3 using corresponding interpolation methods:

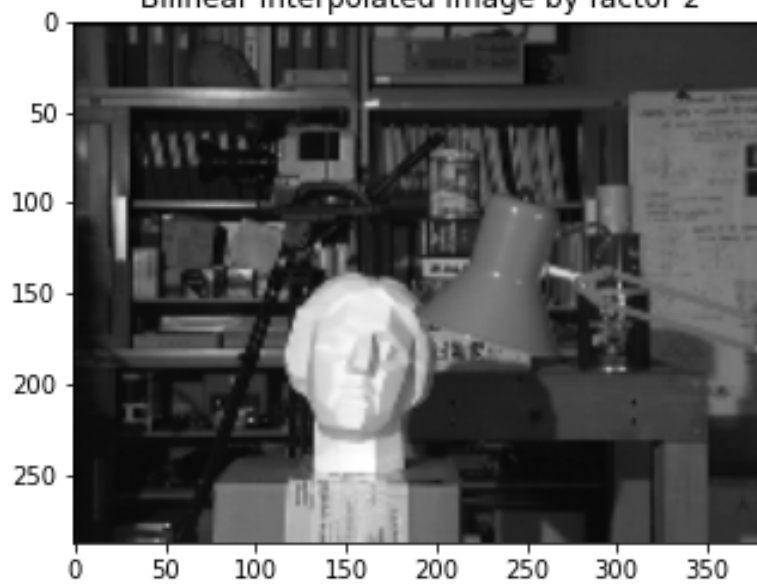


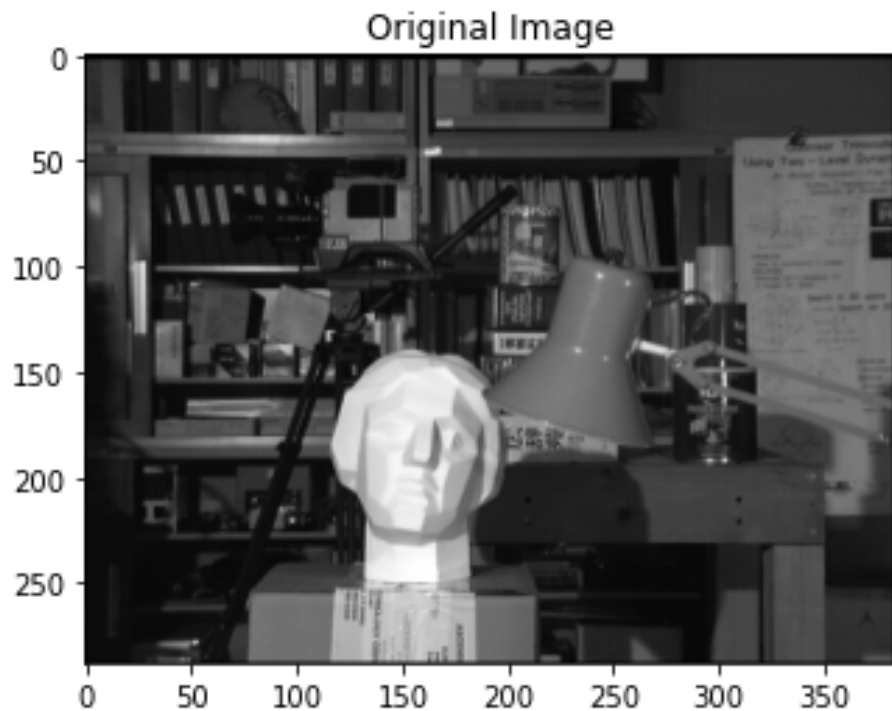


Nearest Neighbour Interpolated Image by factor 2



Bilinear Interpolated Image by factor 2





Mean Squared Error values:

```
Mean Squared Error for Bee.jpg using Nearest Neighbor Interpolation by factor 2 = 28.022074600798405
Mean Squared Error for Bee.jpg using Bilinear Interpolation by factor 2 = 25.89182884231537

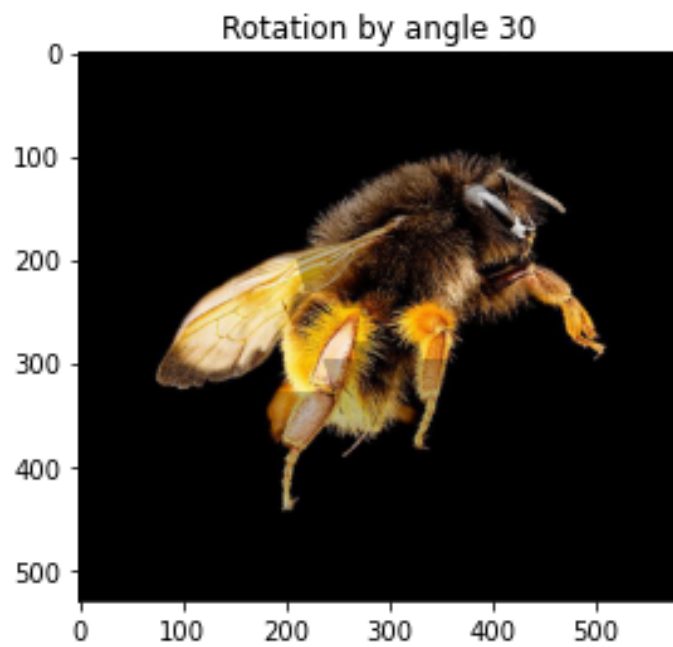
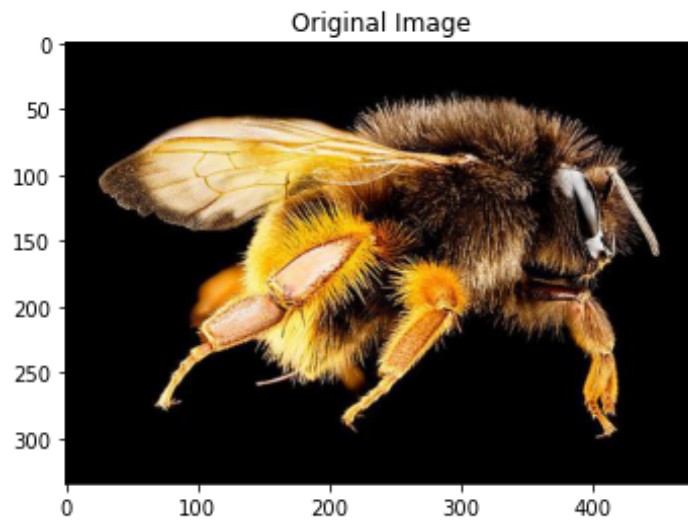
Mean Squared Error for Bee.jpg using Nearest Neighbor Interpolation by factor 3 = 34.679654654654655
Mean Squared Error for Bee.jpg using Bilinear Interpolation by factor 3 = 33.35039414414415

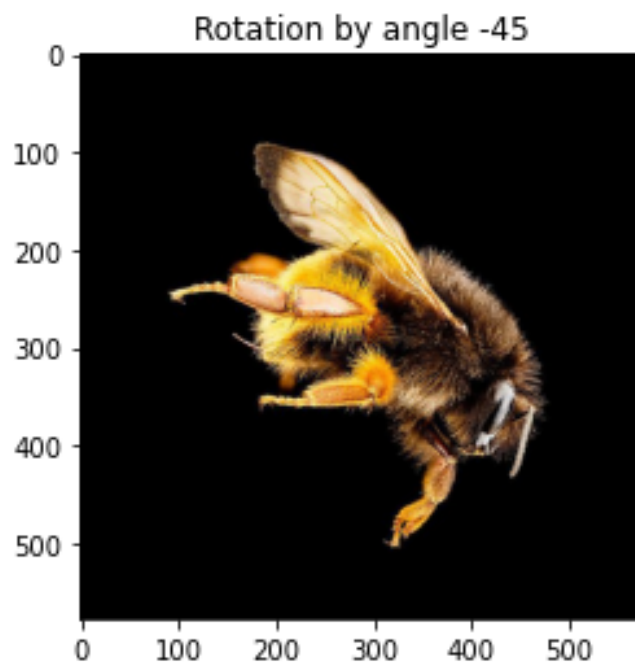
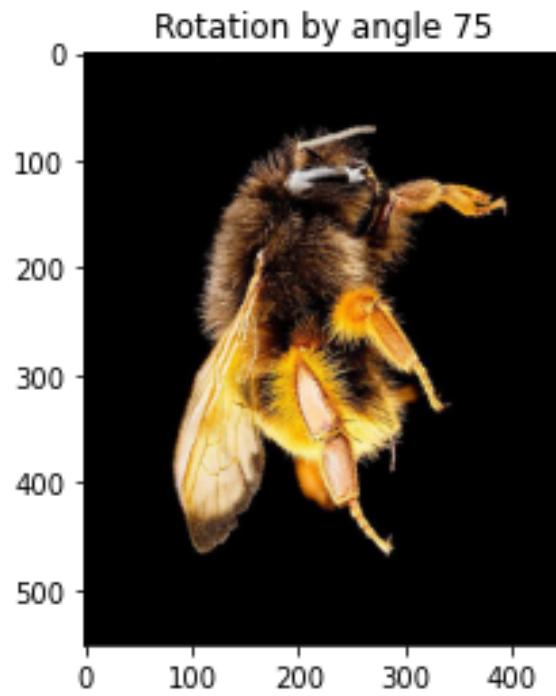
Mean Squared Error for StoneFace.png using Nearest Neighbor Interpolation by factor 2 = 26.892822265625
Mean Squared Error for StoneFace.png using Bilinear Interpolation by factor 2 = 21.355061848958332

Mean Squared Error for StoneFace.png using Nearest Neighbor Interpolation by factor 3 = 38.097683376736114
Mean Squared Error for StoneFace.png using Bilinear Interpolation by factor 3 = 33.8717357494213
```

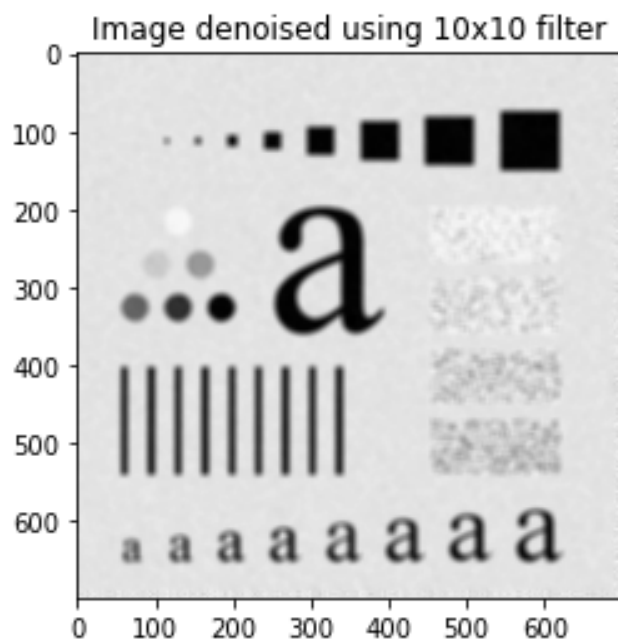
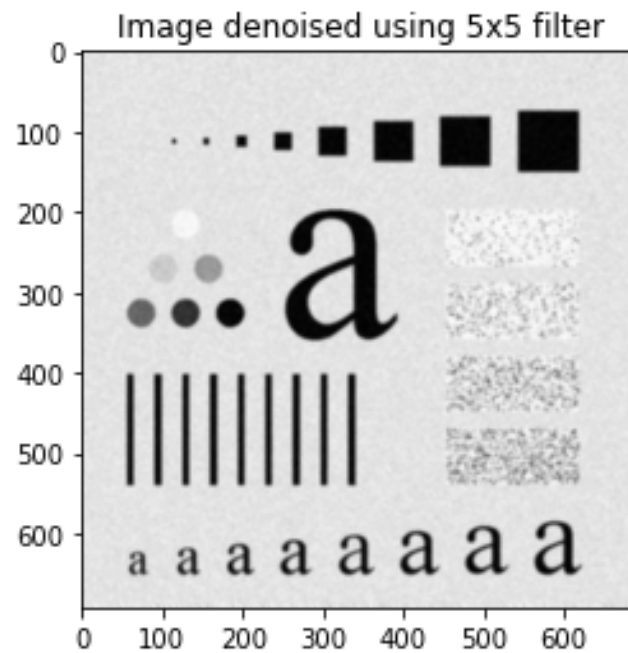
It can be seen from the MSE values that, Bilinear Interpolation gives better results always.

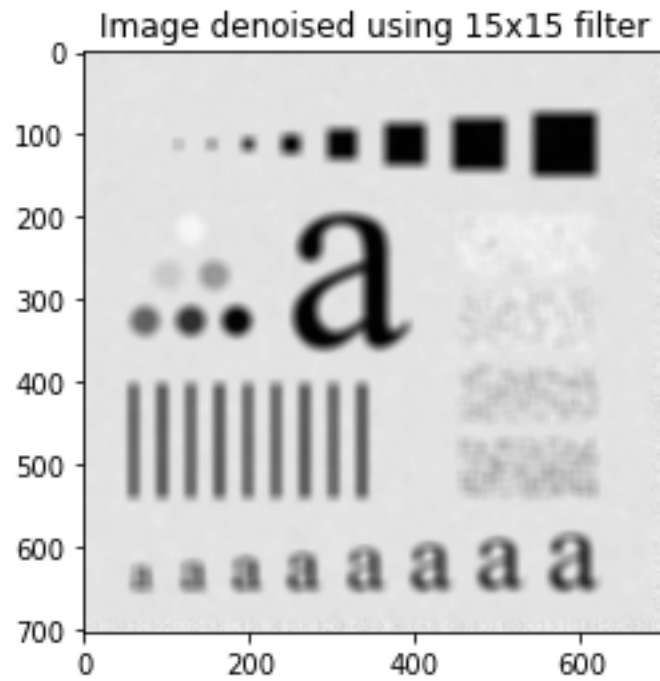
Q3. Rotated Image Outputs:





Q4. a) The images denoised using filters of sizes 5x5, 10x10, 15x15 are:





We can see from the images, as the mask size keeps on increasing, the image gets more blurry.