Harris Corner Detection Report

Assignment 2a Report

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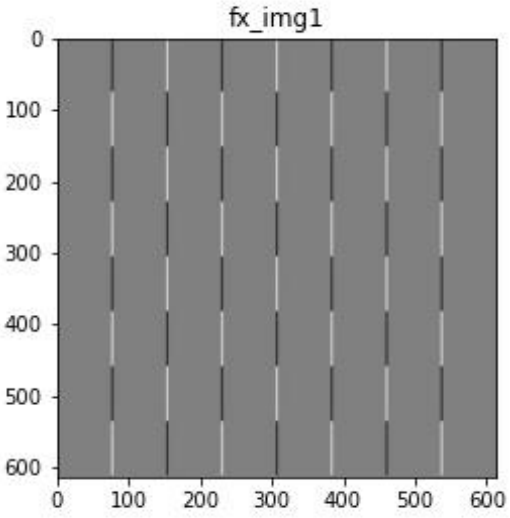
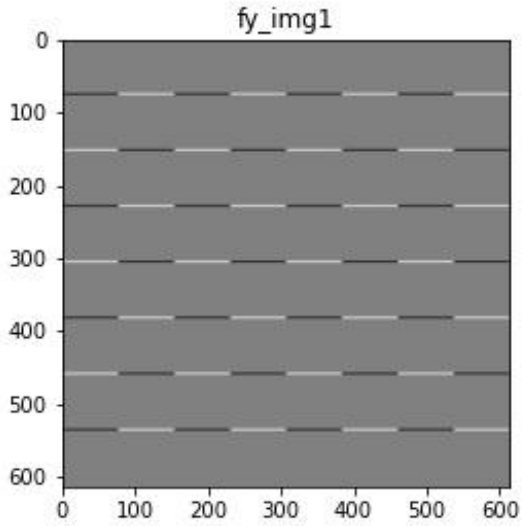
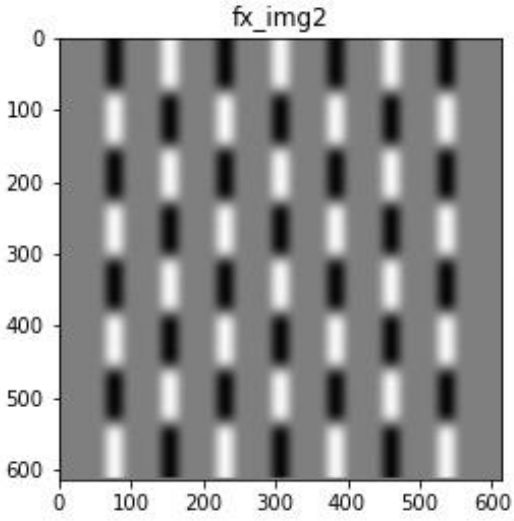
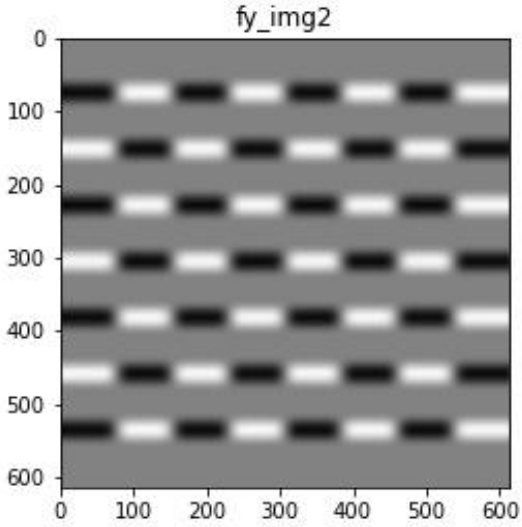
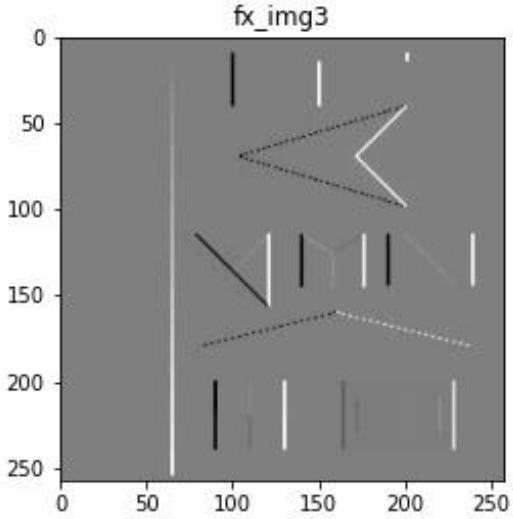
Harris corner detection is an algorithm for detecting corners in an image. The three given images Img1(612,612,3), img2(612,612,3) Img3(256,256,3) were first converted to grey scale. By definition corners are where change occurs in both X and Y direction. First we take the derivatives both in X and Y direction. Gaussian kernel is convolved with an image to take its derivative, Ix and Iy. While convolving with 3x3 filter, the range was kept from 0 to rows-2 and 0 to col-2 so that we don't get index out of bounds exception. After convolution, size of images remain the same but the convolved image has 0 padded layers which will be used in further processes so that final size of image remain the same. Following are the Ix and Iy of the img1, img2, im3 respectively:

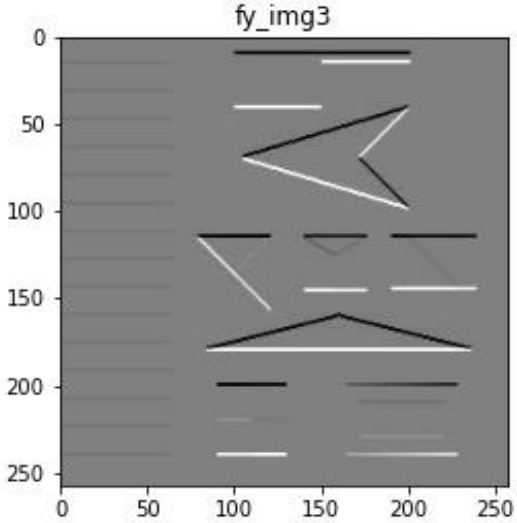






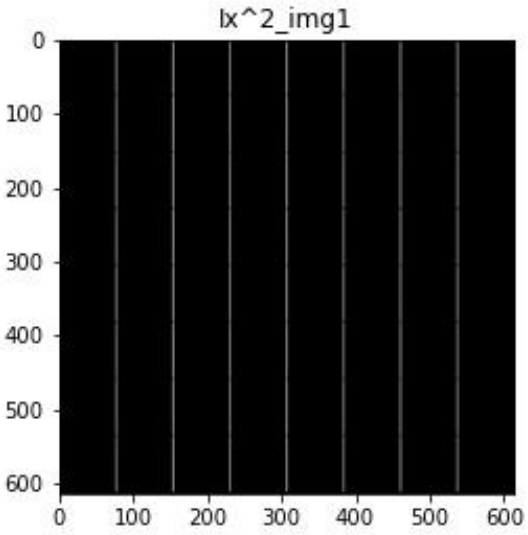


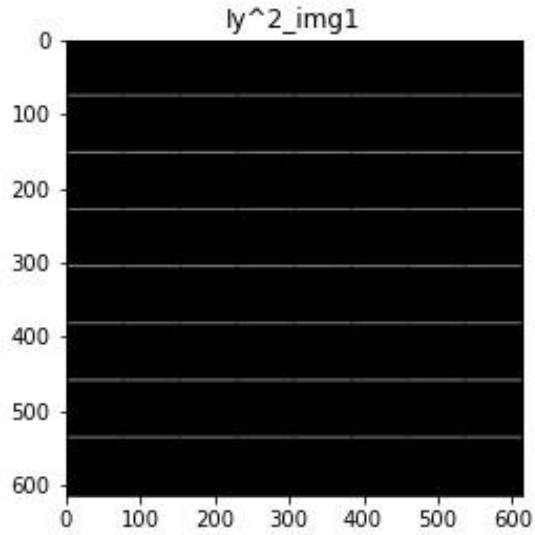




To compute the M matrix we need Ix^2 , Iy^2 and IxIy. Following are the images of Ixx, Iyy, IxIy for the three given images respectively

Image 1: Img1.png





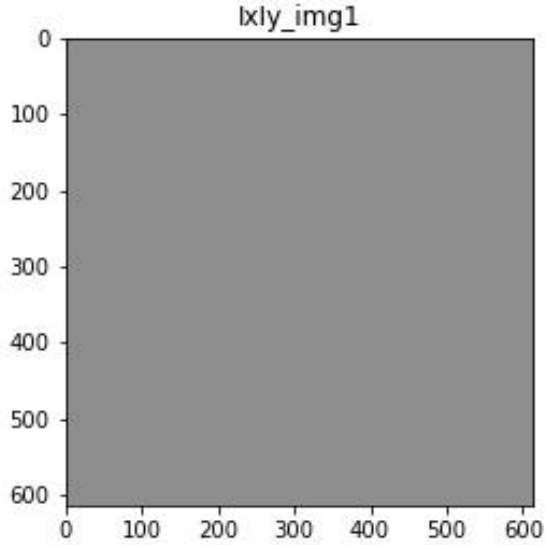
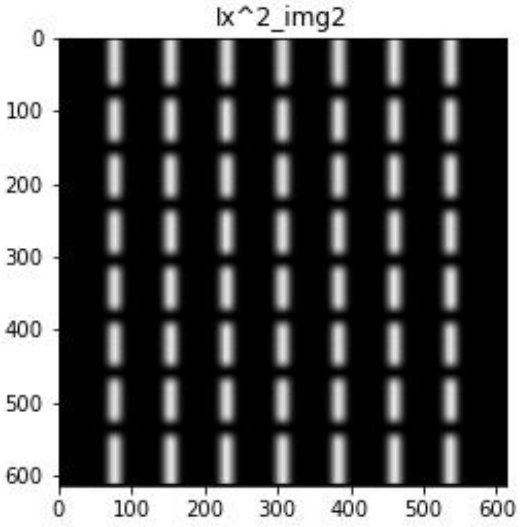
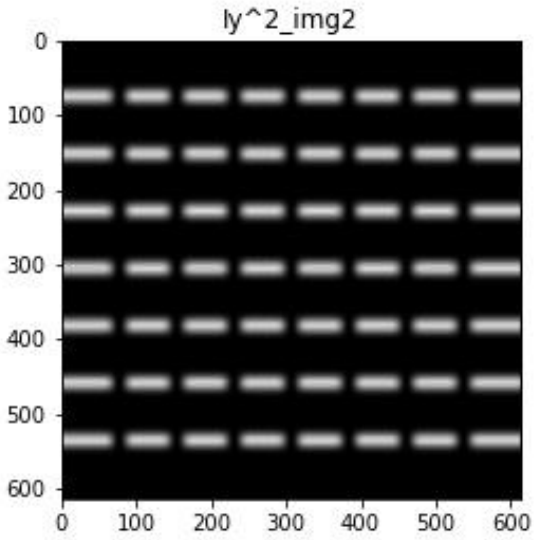


Image 2: Img2.jpg





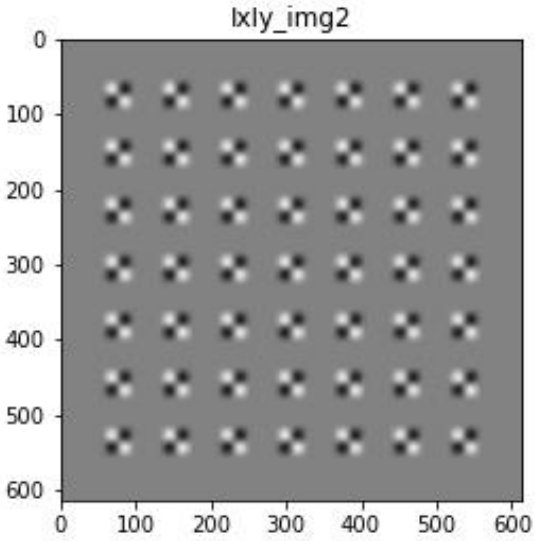
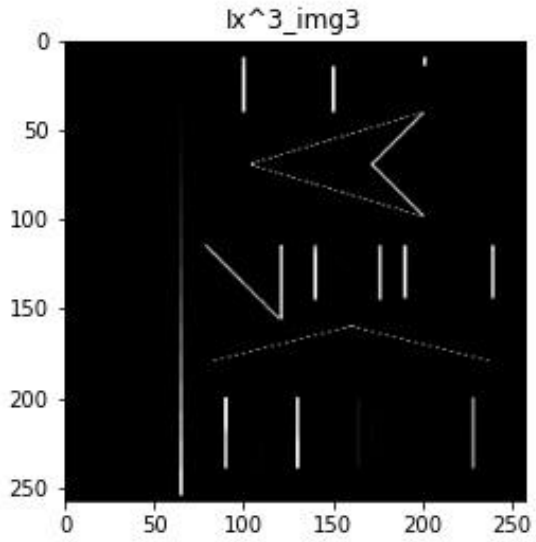
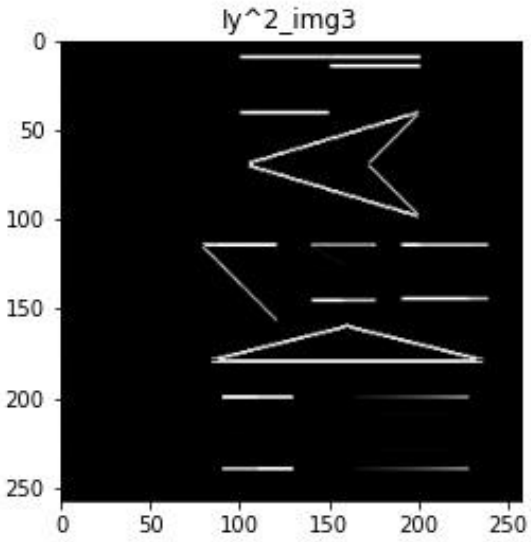
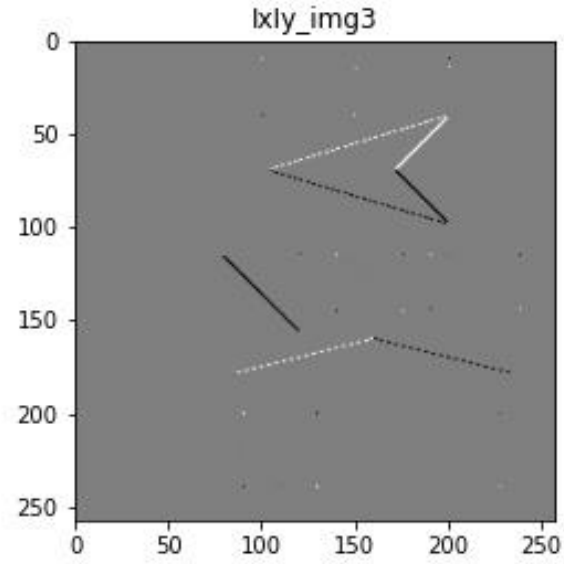


Image 3: Img3.png







Next step is to smooth all the images or weight all the corresponding Ixx Iyy and IxIy. 5x5 Gaussian filter is used to smooth out the corresponding Ixx, Iyy and Ixy.

Next compute the R value by the determinant of M and trace of M. R value is computed for each of the given three images using the Ixx, Iyy and IxIy corresponding values

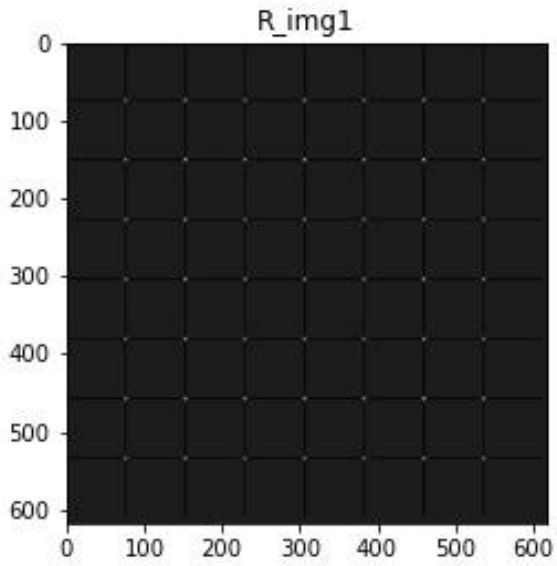
detM = Ixx*Iyy - Ixy**2

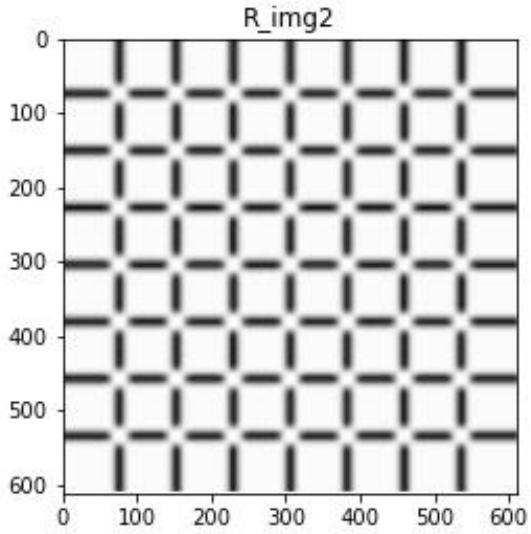
traceM = Ixx+Iyy

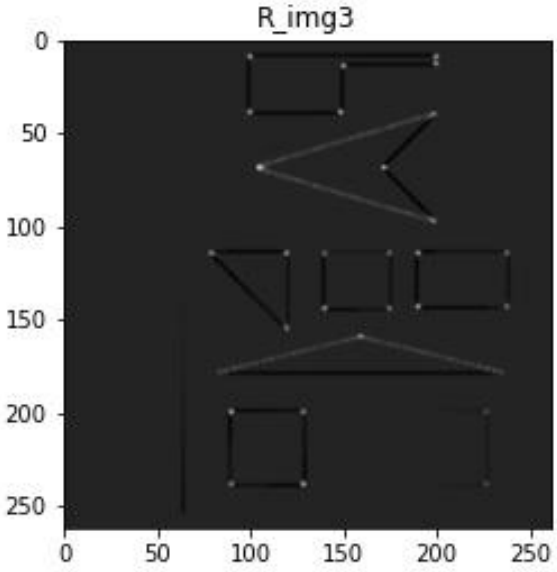
R = detM - k*(traceM)**2

Where k is a value set between 0.04 and 0.06, 0.04 is used here.

The corresponding R images before Non- Maxima suppression are as follows.



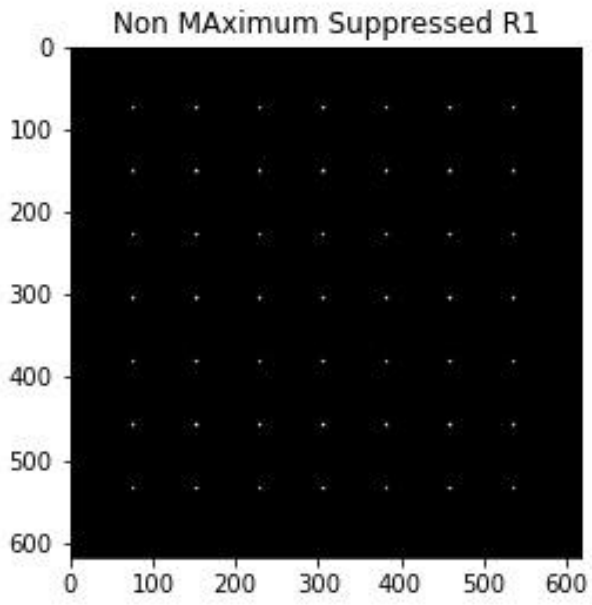


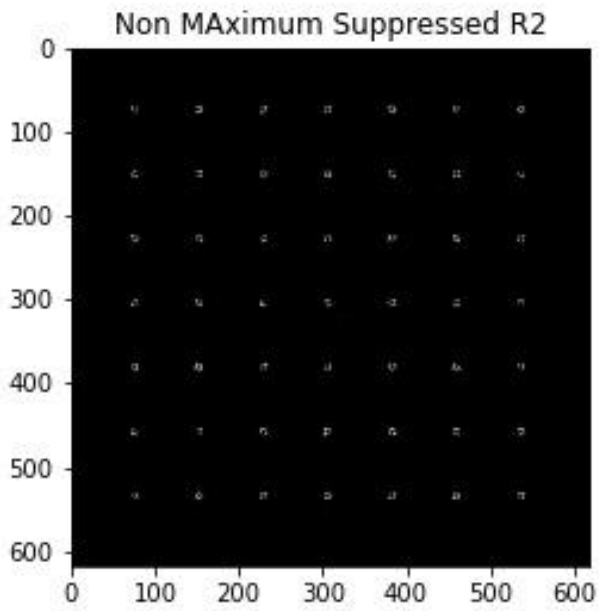


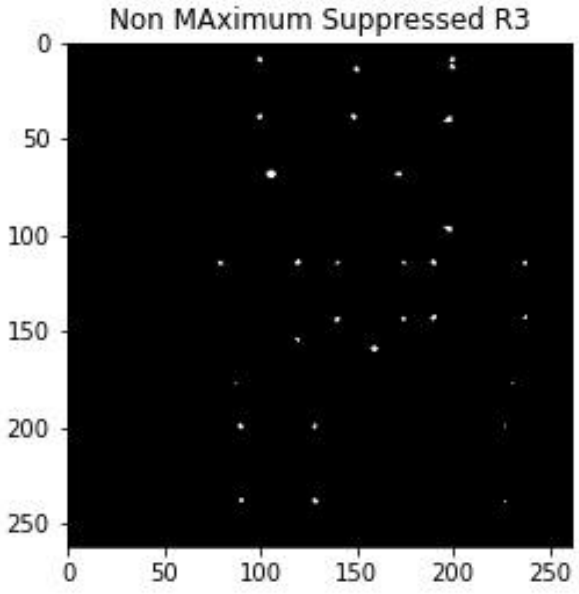
Non maximum suppression is applied on R to suppress the unimportant/noise corners. Lamda1 and Lamda2 are both greater than 0 for a corner and max where there is highest when lamd1, lamda2 are highest, hence take the maximum value in R by R.max() and lower it by some threshold. Then, if a pixel is maximum in its neighborhood and greater than the threshold then declare it a corner otherwise suppress it. For suppression, another matrix of zeros of size R is created and the corner pixel is made 1. The neighborhood for Img1 is 5x5 window whereas for Img2 and Img3 are 7x7 window correspondingly. As Img1 has uniform corners, 5x5 widow window gave perfect results but in case of the other two images 5x5 didn't seem to work well. Both the images have fake or weak corner points, to suppress that we take 7x7 window.

Two thresholds are tested here. First one is 0.3 for Img1 and Img2 and 0.22 for Img3 and second threshold used for all the three images is 0.05. With 0.05 along with the real corner points(higher lamda1 lamda2 value), noise or fake corners are also declared as corners. Whereas Img1 showed perfect result with 0.3, declaring the exact corners as corners but Img2 didn't show as perfect result as Img1. Image is highly blurred version of Img1 so the corner points(change in both X and Y direction) are more in number as compared to Img1 and upon blurring the Ixx, Iyy and Ixy again yield more weaker corner(lower lamda1 lamda2 value) points. Thus we get multiple pluses around and on a real corner in cornered image. Img3 has very sharp shapes but the boundaries of few shapes are zigzagged i.e change in both the directions and hence declaring them as corners. To suppress that, 0.22 threshold value is used.

Images after Non maximum suppression are as follows.

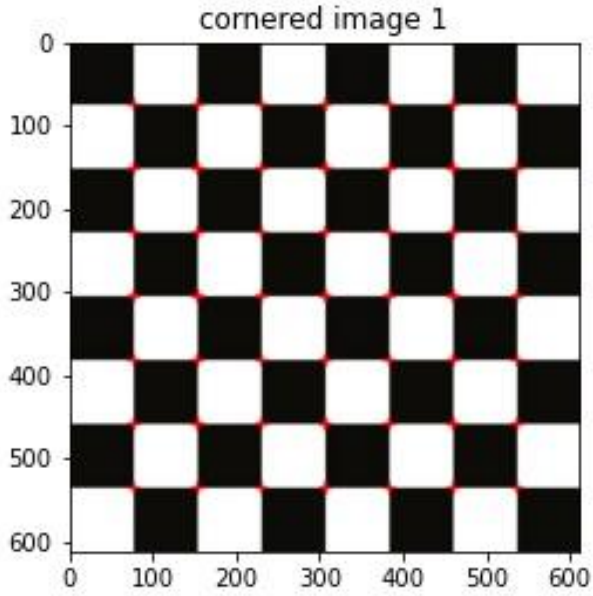


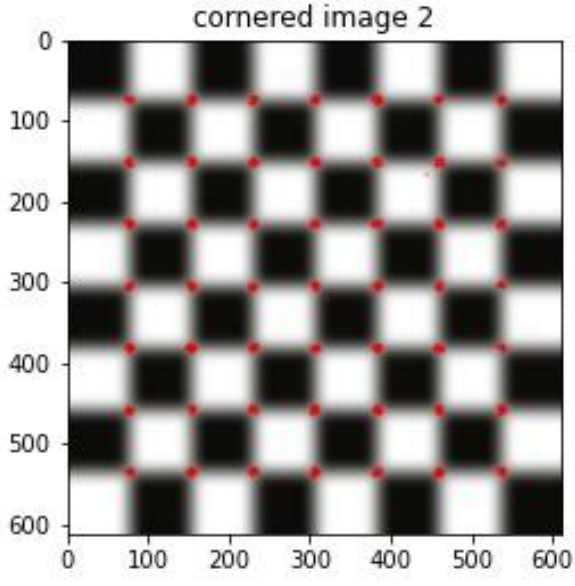


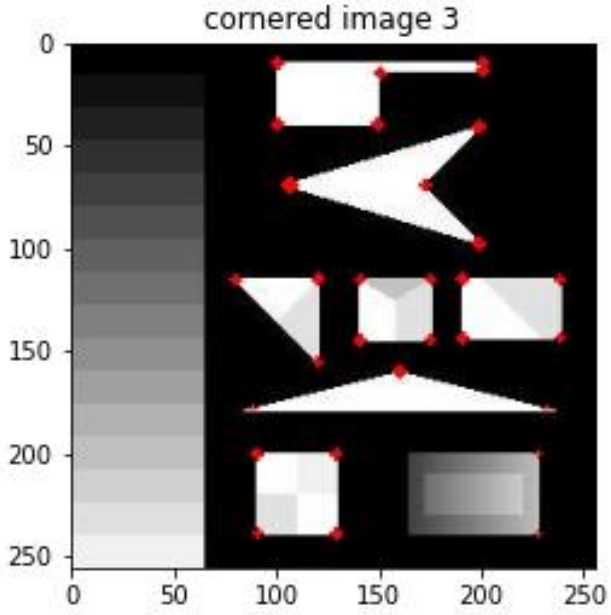


The sizes of corresponding R images are same as the original images but all these 3 R images have one layer of zero padding. This creates a mismatch with indices of a corner pixel in R and its corresponding pixel in the original image. To solve this problem, i+1,j+1 index is chosen in original image to mark it as a corner.

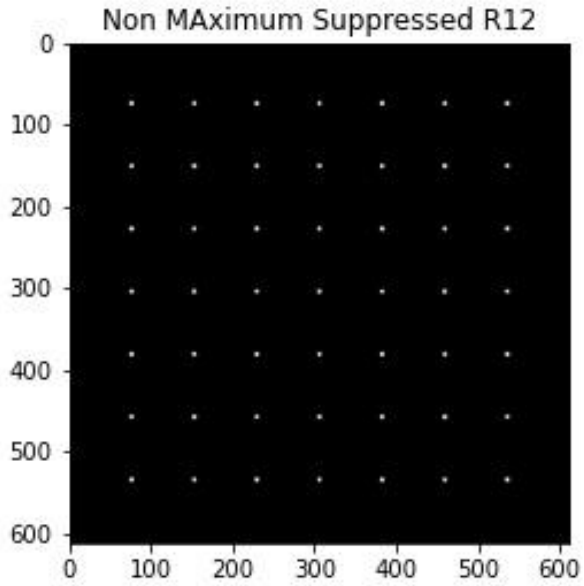
Cornered images with threshold=0.3 for Img1 and Img2 and 0.22 for Img3

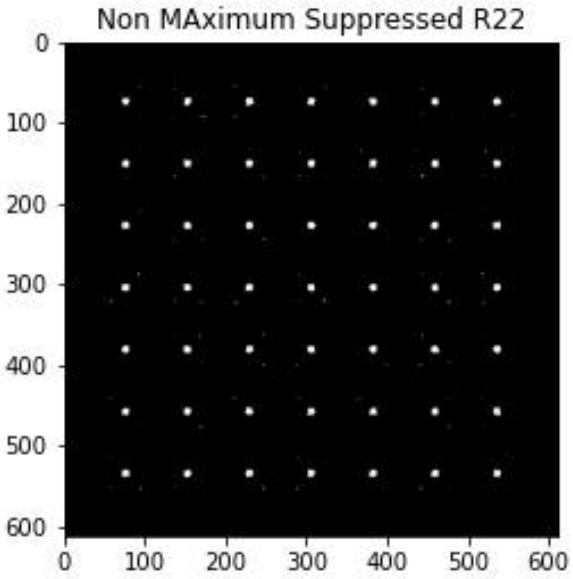


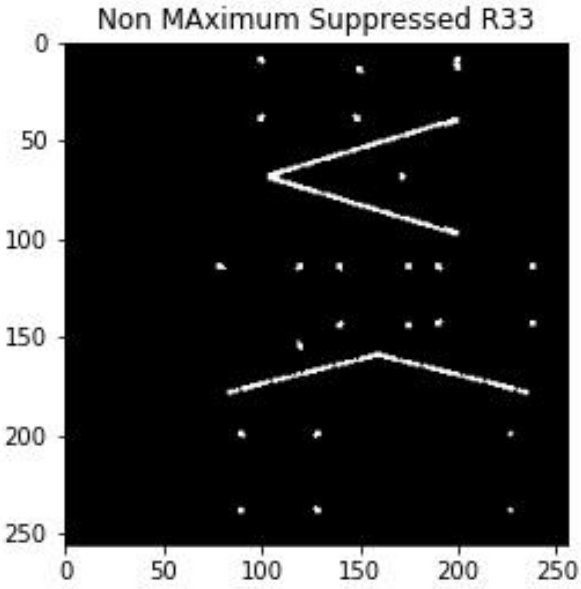




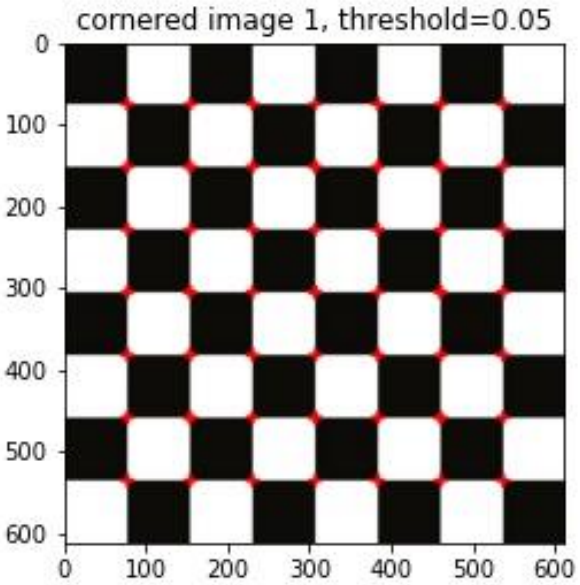
Non_Maximum suppressed Images with threshold=0.05 are as follows.

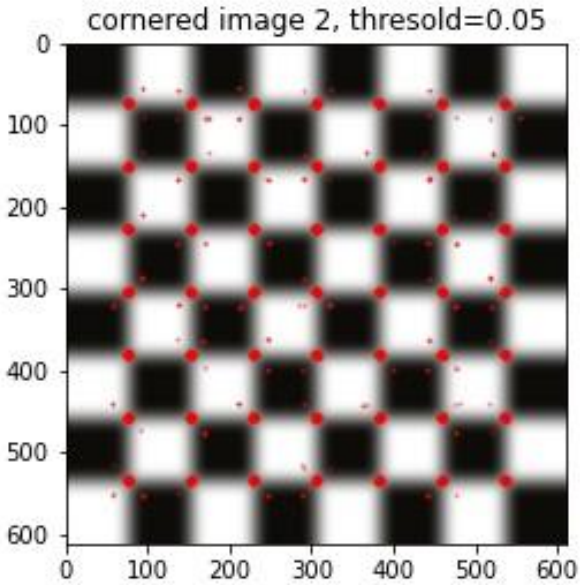


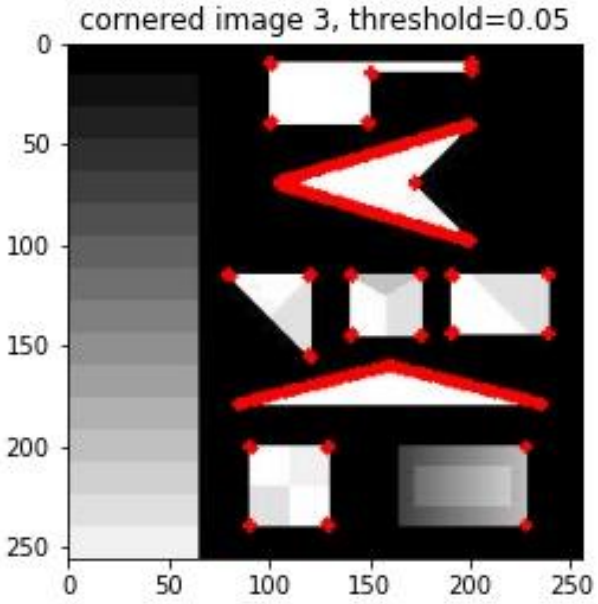




The images with 0.05 threshold as follows:







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