Harris Corner Detector Practical Exercise

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May 10, 2021

Harris Corner Detector is a mathematical approach for finding corners in a images.This method was proposed by Chris Harris & Mike Stephens in the 1980's.The change in intensity of the pixel values combined with the windows function and measure of cornerness where mathematical defined from the shift in intensity to find the corners. Let I be the image and W be the window function(binary or Gaussian).then the Change of intensity for the shift [u, v] where u,v are the pixel index.

$$E(u,v) = \sum_{x,y} w(x,y)[I(x+u, y+v) - I(x,y)]^2 \tag{1}$$

This equation can approximated for small changes with Taylor's series and bi-linear approximation as:

$$E(u,v) \approx [u,v]M \begin{bmatrix} u \\ v \end{bmatrix} \tag{2}$$

where M is a 2x2 Matrix computed from the image derivatives

$$M = \sum_{x,y} w(x,y) \begin{bmatrix} I_x^2 & I_x I_y \\ I_x I_y & I_y^2 \end{bmatrix} \tag{3}$$

from the M we can get the cornerness (R) as $R = det(M) - k(trac(M))^2$ with k is empirically determined constant in the range of 0.04 to 0.06.

Matlab Implementation

I have implemented the Harris corner in matlab by taking the window function as Gaussian,and the threshold as a mean of all the R values and multiplying with a constant value so that I don't define the threshold each time.First I tried with the checker board image in figure

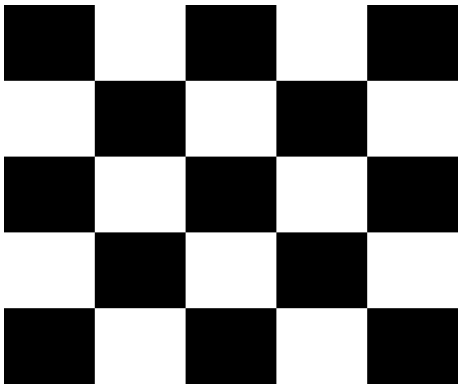
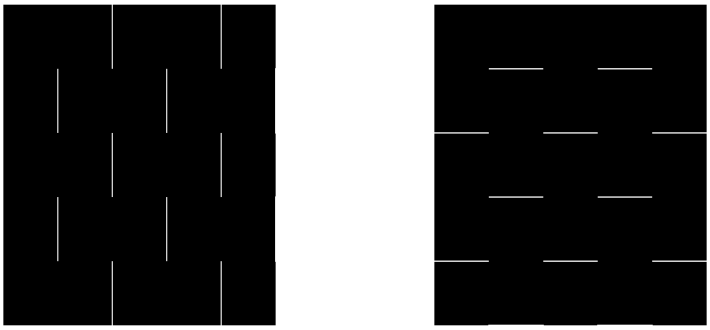


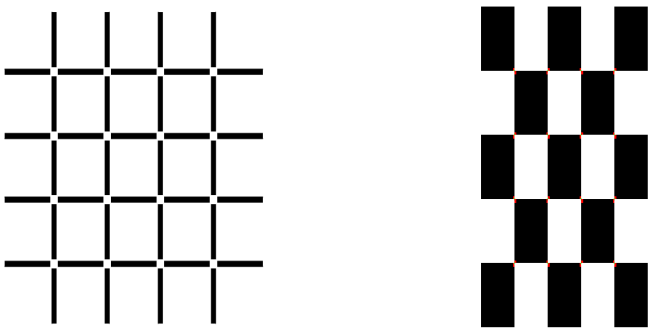
Figure 1: Checkerbox image



(a) Derivative in X direction **(b)** Derivative in Y direction

Figure 2: Derivative of the image.

The derivative of the image is the change in the pixel value in the direction,Since the image is with checker board we can see the differences in the derivative.



(a) Heatmap of the R **(b)** Corners Detected in the red

Figure 3: Heat map and corners detected

The heat map is the value of scaled up to be in the range of 0 to 255 to visualise.In the image(b) of figure 3 the corners detected are visualised with the red colour as markers,the corners are detected as the area rather than the a point because the I have defined the threshold to be over limit of the threshold,the corner with point can be found using the peek value method.

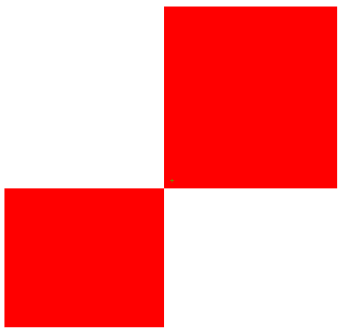


Figure 4: comparing the detected corner with the matlab's implementation

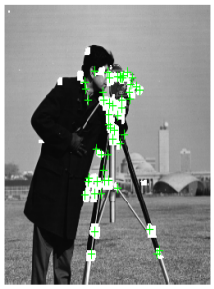
Comparing the matlab's implementation of the harris corner the corners are peek value limit and not the threshold limits.The red is the corner detected and the green is the matlab's in-built result.The implementation took about 4 seconds to compute the corners

(a) Cameraman image

(b) Derivative in X direction

Figure 5: Original image and Derivative on the image

(a) Derivative in Y direction



(b) Corners Detected

Figure 6: Derivative and corners detected on the image

The results on the cameraman image is the white-coloured area and the green plus marks are the results from the inbuilt function.This is image took about 1.5 seconds to compute the corners.

Conclusion

The Harris corners detector is a easy to implement algorithm on Matlab since its a mathematical derivation.My implementation takes about 5 seconds to compute the corner for images of larger size and about 2 seconds for smaller image.The computation time increase as the size of image increases