UNIVERSITY of LIMERICK

OLLSCOIL LUIMNIGH

Harris Corner Detection

Machine Vision – RE4017
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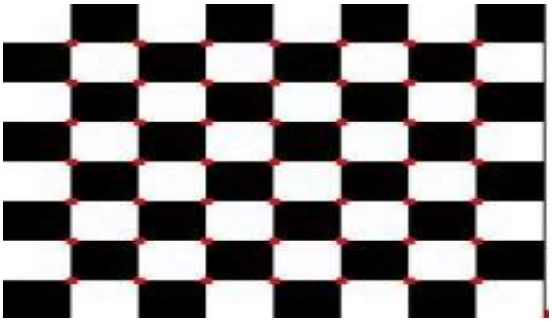
Introduction

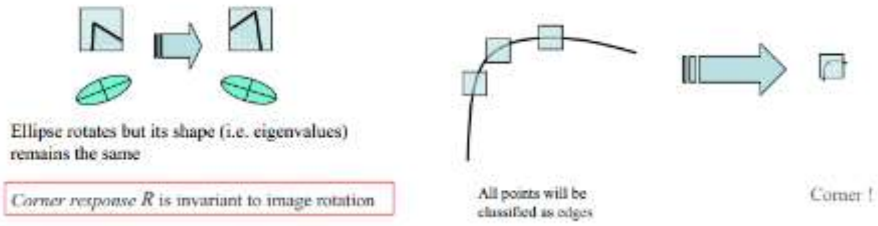
Corner detection is a method used in computer vision systems to extract certain features and deduce the contents. Corner detection is used frequently in video tracking, stitching motion detection and object recognition. Corner detection overlaps with the topic of interest point detection.

Here we are going to explore using Harris corner detection to stitch two different images together. It picks corners because, since it is the intersection of two edges, it represents a point in which the directions of these two edges change. Hence, the gradient of the image (in both directions) have a high variation, which can be used to detect it.



See here how Harris corner detection detects all the corners of this checkers board (shown in red). Using a similar principal we will detect all the corners in images and apply this information by stitching them together.

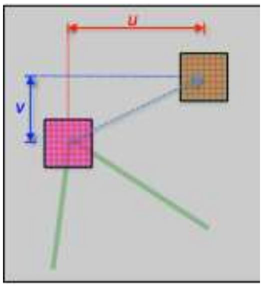
Harris Corner detection is rotation invariant, if it is rotated the shape/eigenvalues remains the ssame and i9t is also non invariant to image scale.



Harris Corner Detection Mathematics

Measuring difference:

One approach: Calculate the Sum of Squared Differences between the original patch and its shifted version. Where U and V are as shown below.



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

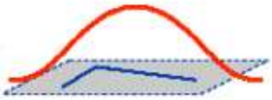
Window Function:

Window function governs the amount of surrounding area in a patch

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

$w(x,y) =$

or



Uniform: 1 in window, 0 outside.

2-d Gaussian:

Harris Detector: Intuition:

Change of intensity for the shift (u,v):

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

Window function

Intensity of "shifted" patch: shift (u, v).

Intensity of patch

For nearly constant patches this will be near 0.

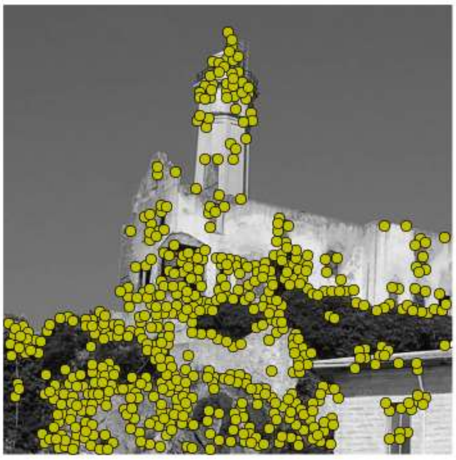
For very distinctive patches this will be larger.

Hence: we want patches where E(u,v) is LARGE

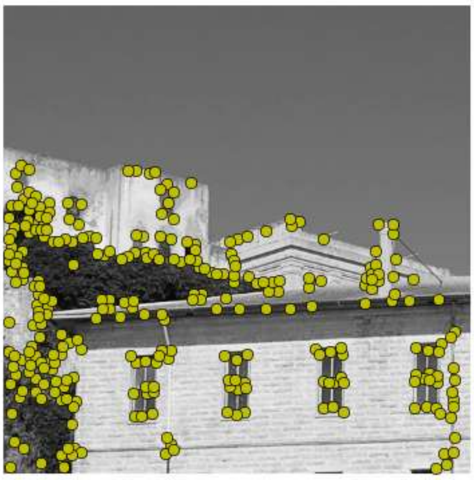
2d Taylor series expansion:

$$f(x+u,y+v) \approx f(x,y) + u f_x(x,y) + v f_y(x,y)$$

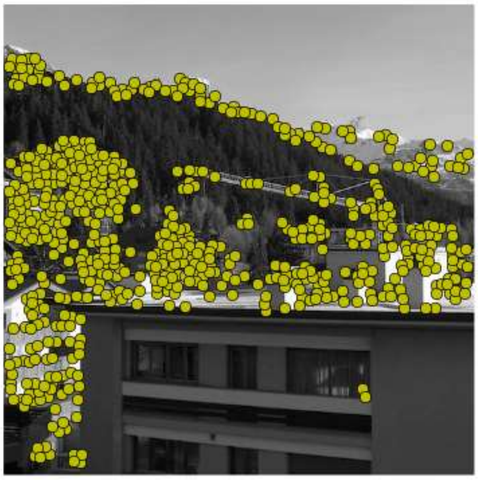
Harris Interest Points



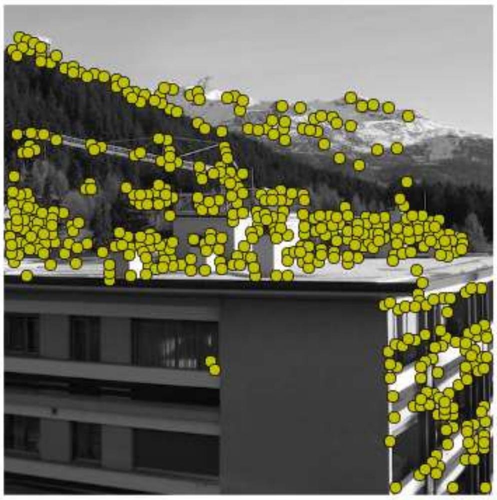
Al 1



Al 2



Cr 1



Cr 2

Image Mapping

Code from above Harris Interest Points was modified to provide the image mapping feature below as seen in attached .py file.