Harris Feature Point

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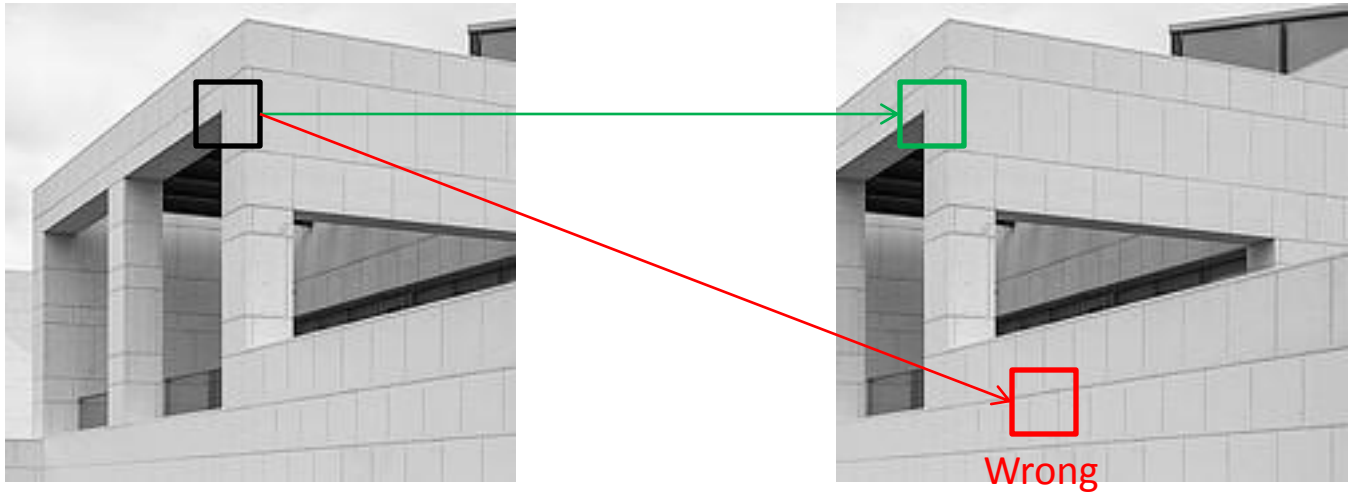
Motivation: Patch Matching

In computer vision, motion detection and estimation requires finding corresponding features across two or more views.

Motivation: Patch Matching

Properties of these Features

- These features should be chosen so that they match only to their corresponding patches in other slightly moved image.
- Example :



Harris Detector : Idea

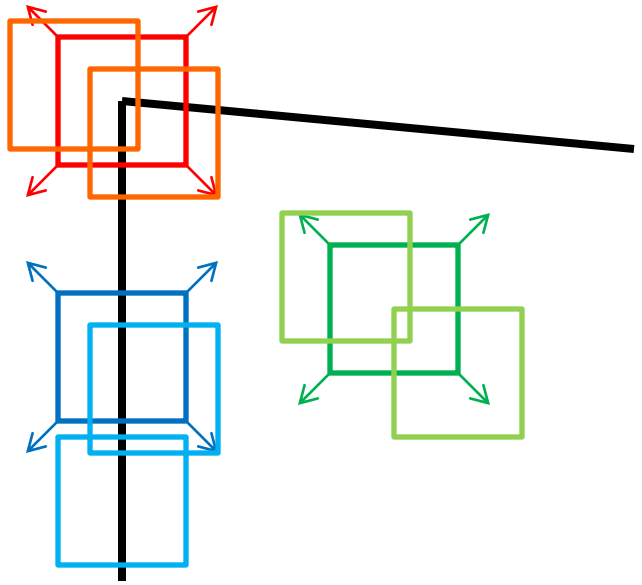
Defining good or bad feature:

Let us consider some small patches as the candidates for the feature.

- Red patch would be called good feature because in slightly moved image it is more probable to occur only once.

- Blue patch is not a good feature. Because it could be found to be occur in image multiple times along the line.

- Green patch is not a good feature because its on flat resign and have no change on moving in any direction.



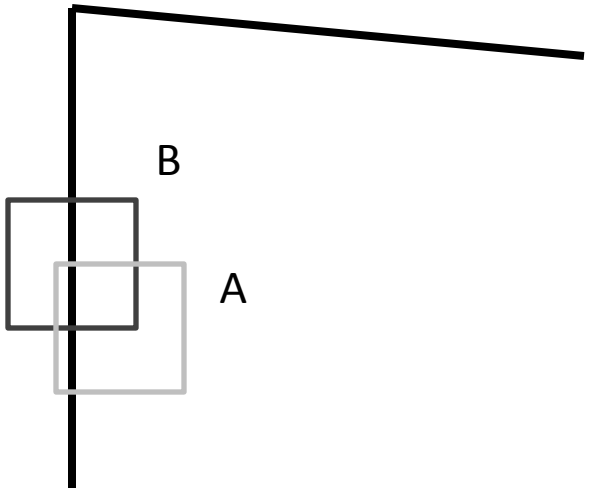
Harris Detector : Mathematics

Considering small motion, let E(u,v) is SSD error obtained after comparing each pixel of B (before moving) and A (after moving by (u, v)) by summing up the squared differences.

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

After solving further :

$$E(u,v) = \sum_{(x,y)\in W} [u \ v] \underbrace{\begin{bmatrix} I_x^2 & I_x I_y \\ I_y I_x & I_y^2 \end{bmatrix}}_{\mathbf{H}} \begin{bmatrix} u \\ v \end{bmatrix}$$



Harris Detector : Mathematics

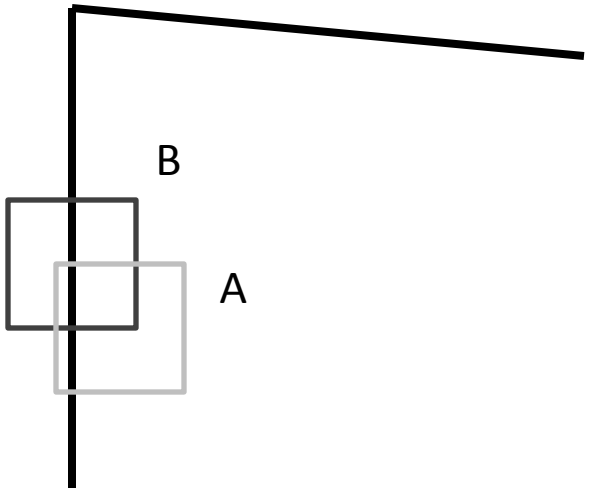
$$E(u,v) = \sum_{(x,y)\in W} [u\ v] \begin{bmatrix} I_x^2 & I_x I_y \\ I_y I_x & I_y^2 \end{bmatrix} \begin{bmatrix} u \\ v \end{bmatrix}$$

The good features can be detected by maximum SSD error on each pixel

By maximizing SSD, we mean that by moving B the new patch A matches least.

Here , patches containing corner points (Red) are the patches which on movement gives maximum error.

While patches like Blue and Green ones will give least error.



Harris Detector : Mathematics

Want *E(u,v) to be large for small shifts in all directions*

- Compute the gradient at each point in the image
- Create the *H matrix from the entries in the gradient*
- Compute the eigenvalues.
- Find points with large response (λ- > threshold)
- Choose those points where λ- is a local maximum as features