



# Other Linear Filters

CS 211A

Slides from Cornelia Fermüller and Marc Pollefeys



## Corner Detection (Non-linear filter)

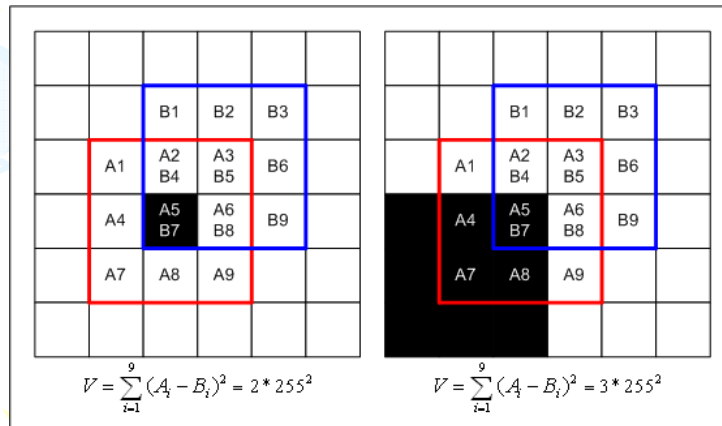
- Corners have more edges than lines
- Should be easier
- But edge detectors fail – why?
  - Right at corner, gradient is ill-defined
  - Near corner, gradient has two different values

## Moravec Operator

- Self-similarity
  - How similar are neighboring patches largely overlapping to me?
- Most regions - Very similar
- Edges - Not similar in one direction (perpendicular to edge)
- Corners – not similar in any direction
- Interest point detection – not only corners

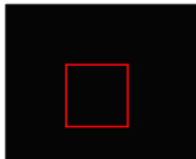
## Measuring self-similarity

- SSD = Sum of squared differences
- Corner is local maxima




## Limitations


- Sensitive to noise
  - Responds for isolated pixel
- Larger patches for robustness




A. Interior Region  
Little intensity variation  
in any direction



B. Edge  
Little intensity variation  
along edge, large  
variation perpendicular  
to edge



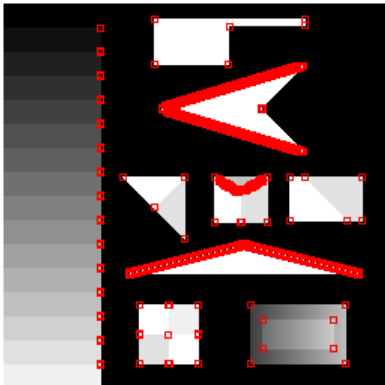
C. Edge  
Large intensity variation  
in all directions



D. Edge  
Large intensity variation  
in all directions

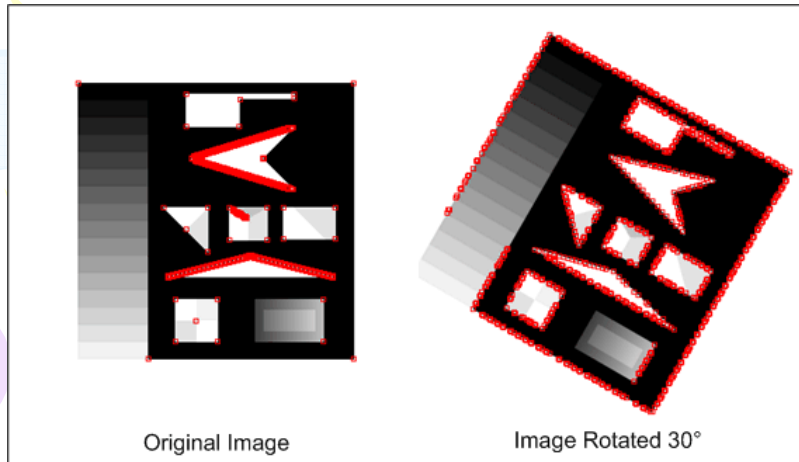
## Limitations

- Responds also to diagonal edges



## Limitations

- Anisotropic (Not rotationally invariant)



## Harris & Stephens/Plessey Corner Detector

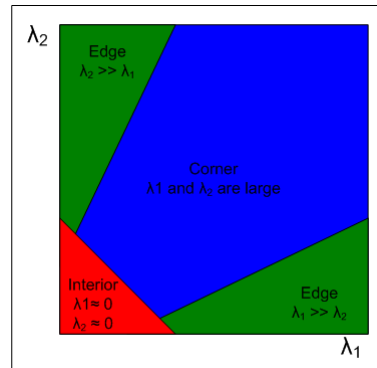
- Consider the differential of the corner score with respect to direction
- Describes the geometry of the image surface near the point  $(u, v)$

$$A = \sum_u \sum_v w(u, v) \begin{bmatrix} I_x^2 & I_x I_y \\ I_x I_y & I_y^2 \end{bmatrix} = \begin{bmatrix} \langle I_x^2 \rangle & \langle I_x I_y \rangle \\ \langle I_x I_y \rangle & \langle I_y^2 \rangle \end{bmatrix},$$

Hessian Matrix  
(Second derivatives of  
multi-variate function)

## How to find the corner?

- The eigenvalues are proportional to the principal curvatures
- If both small, no edge/corner
- If one big and one small, edge
- If both big, then corner



## Rotationally Invariant

- If  $w$  is Gaussian, then this is isotropic

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