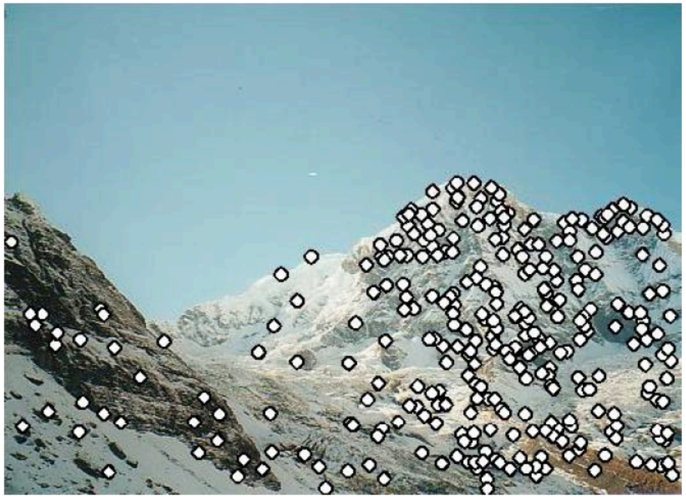
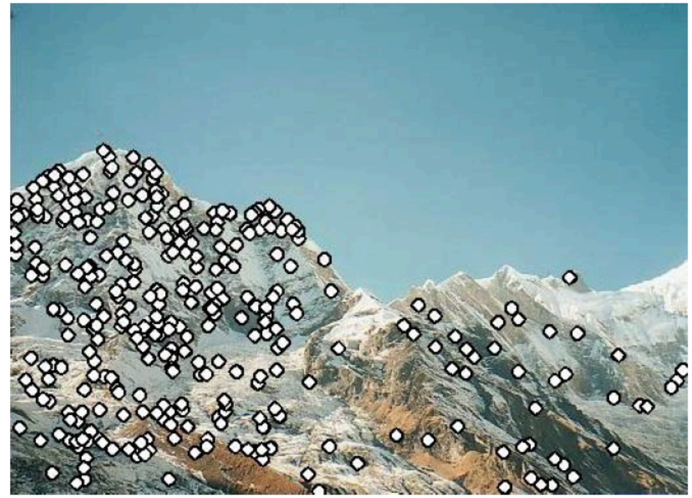
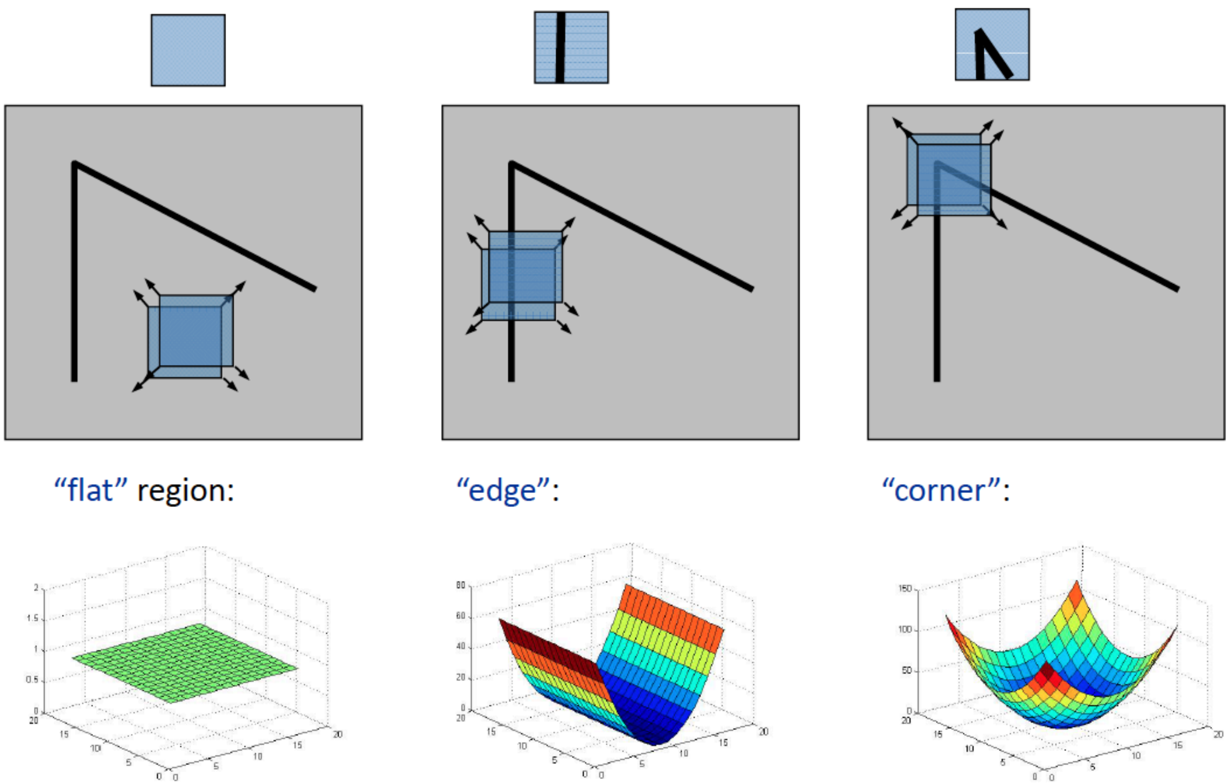



COMP 9517 Computer Vision

Feature Detection

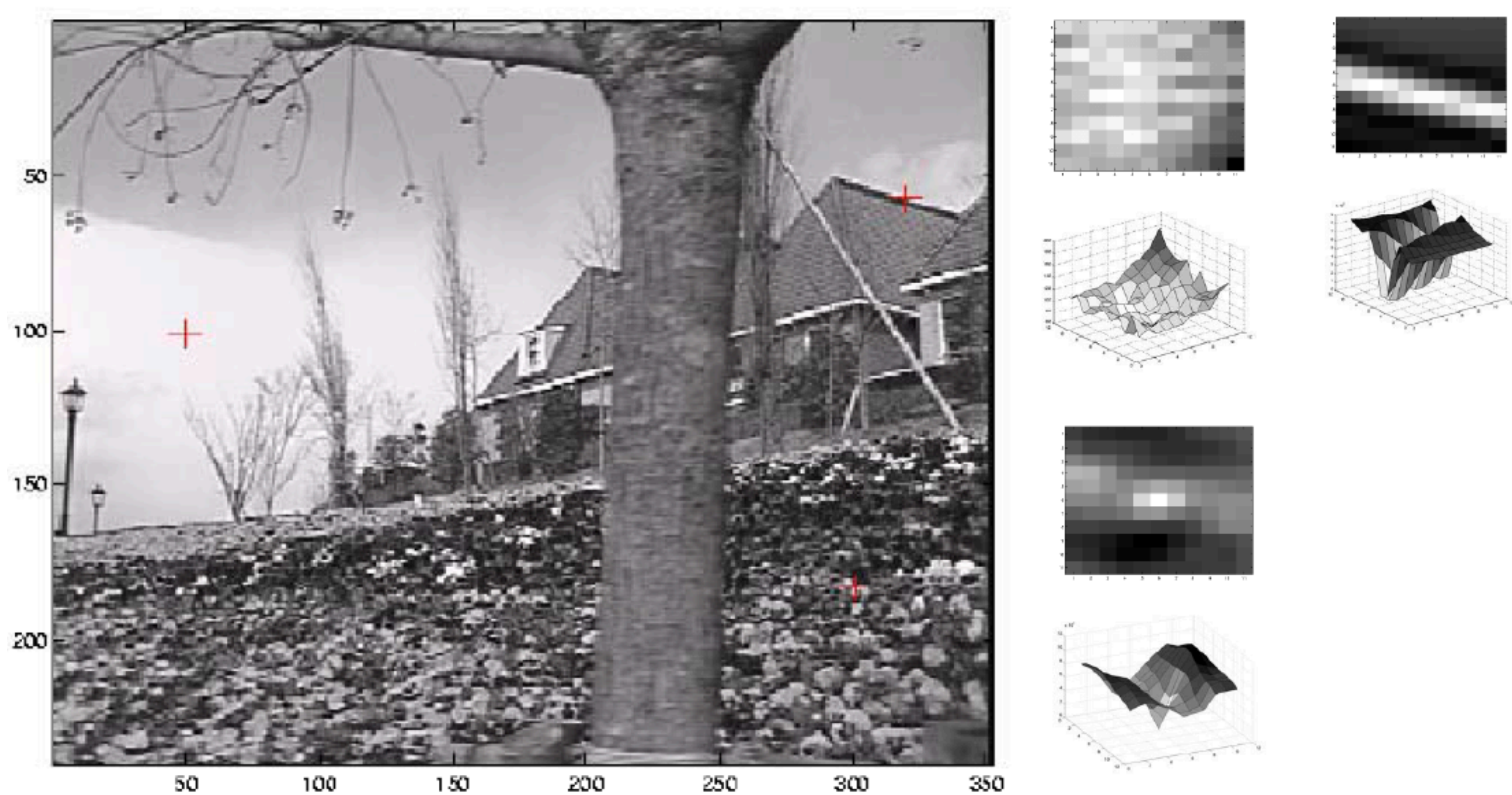
Properties of Feature Points

- What are good feature points?



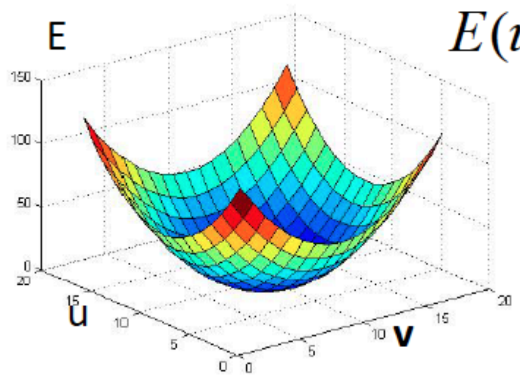
Properties of Feature Points

- What are good feature points?



Harris Detector

- “interestingness” ≈ High change of intensity when shift
- Change of intensity for the shift [u, v]:



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

Window function

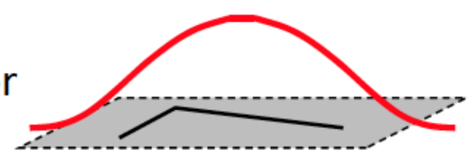
Shifted intensity

Intensity

Window function $w(x,y)$ =

1 in window, 0 outside

or



Gaussian

Harris Detector

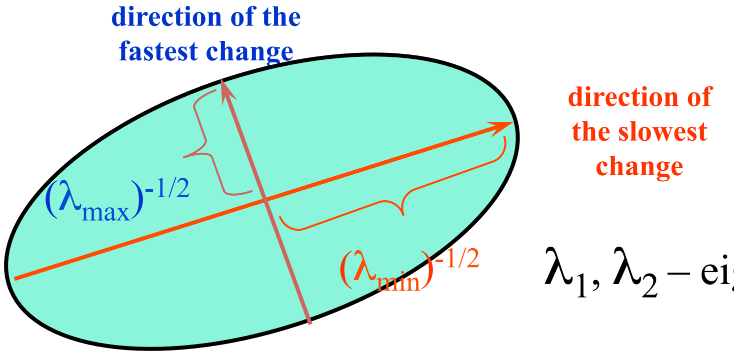
- For small shifts [u, v] we have a bilinear approximation:

$$E(u,v) \cong [u,v] \; M \begin{bmatrix} u \\ v \end{bmatrix}$$

where *M* is a 2×2 matrix computed from image derivatives

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

- Eigen analysis



λ_1, λ_2 – eigenvalues of M

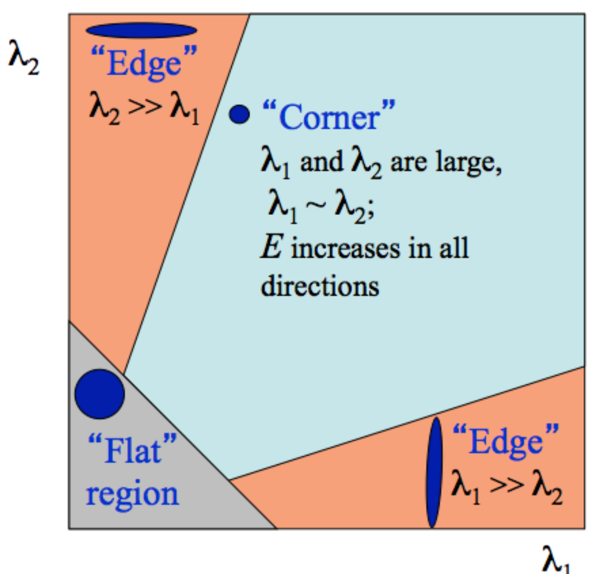
Harris Detector

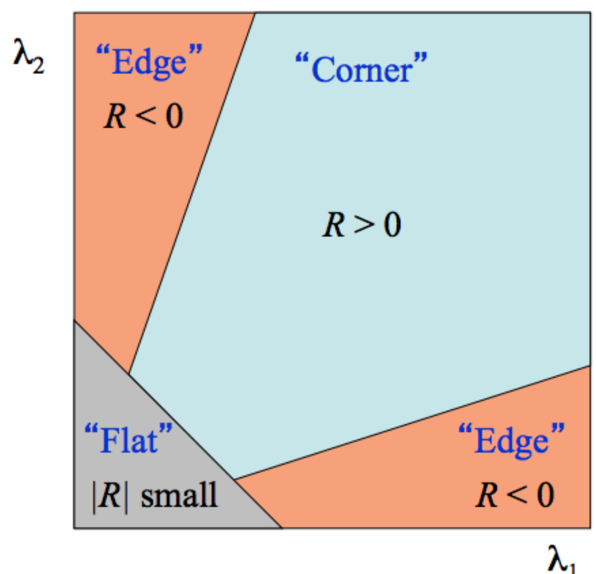
- Measure of corner response

$$R = \det M - k\left(\operatorname{trace} M\right)^2$$

$$\det M = \lambda_1 \lambda_2$$
$$\operatorname{trace} M = \lambda_1 + \lambda_2$$

(k – empirical constant, k = 0.04-0.06)





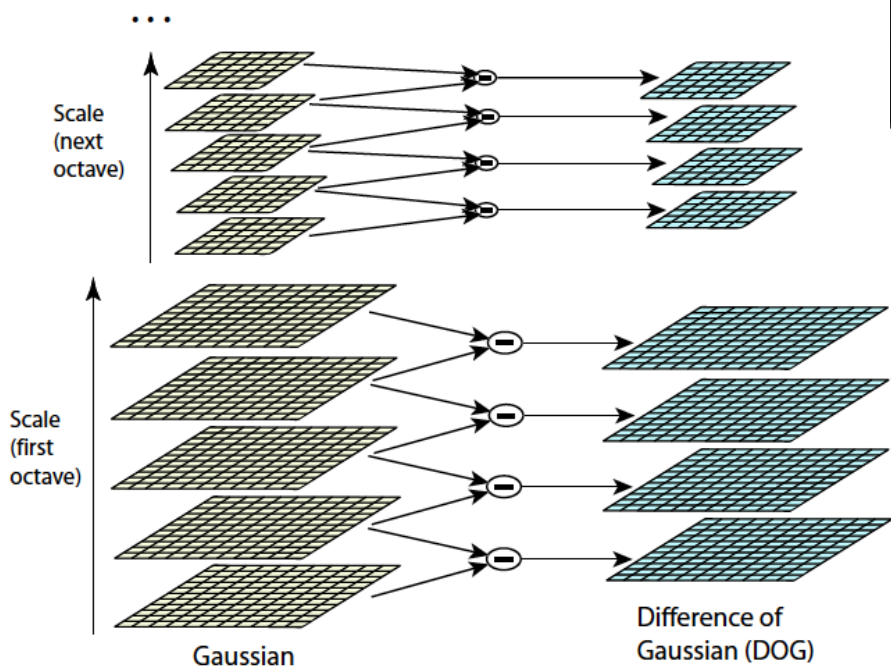
Harris Detector

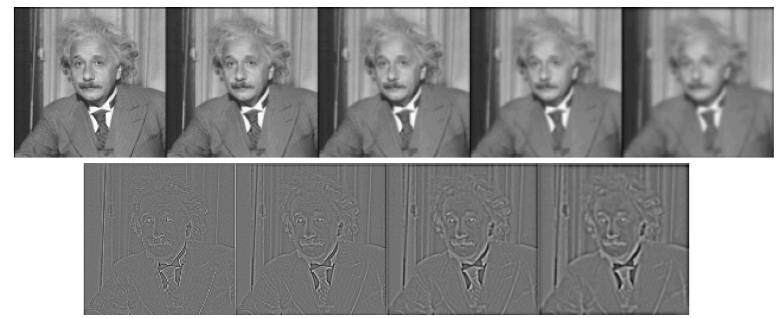
- The algorithm

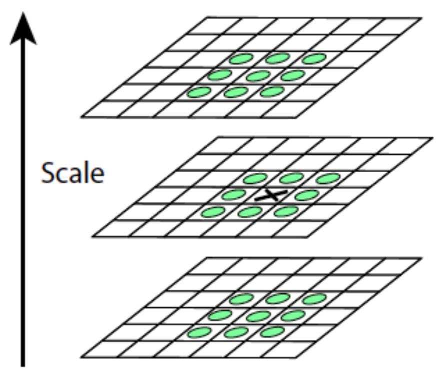
1. Compute the horizontal and vertical derivatives of the image I_x and I_y by convolving the original image with derivatives of Gaussians (Section 3.2.3).
2. Compute the three images corresponding to the outer products of these gradients. (The matrix $\boldsymbol{A}$ is symmetric, so only three entries are needed.)
3. Convolve each of these images with a larger Gaussian.
4. Compute a scalar interest measure using one of the formulas discussed above.
5. Find local maxima above a certain threshold and report them as detected feature point locations.

Scale Invariant Detectors

- Scale Invariant Feature Transform – SIFT







- Extremes (maxima & minima) in the resulting 3D volume are detected by comparing a pixel to its 26 neighbours

References and Acknowledgements

- Szeliski, Chapter 4
- Some content are extracted from the above resource and James Hays slides