Feature Descriptors

Local/Patch

- SIFT
- SURF
- FAST
- BRIEF
- ORB (≈FAST+BRIEF)
- GLOH

Global/Object

- HOG
- GIST
- Shape Context

Speeded Up Robust Features (SURF)
Features from accelerated segment test (FAST)
Binary Robust Independent Elementary Features (BRIEF)
Oriented FAST and rotated BRIEF (ORB)

Speeded Up Robust Features (SURF)

- Partially inspired from SIFT
- Several times faster than SIFT
- Claimed to be more robust than SIFT
- Feature detection: SURF uses an integer approximation of the determinant of Hessian blob detector, which can be computed with 3 integer operations using a precomputed integral image.
- Feature descriptor: SURF is based on the sum of the Haar wavelet response around the point of interest. These can also be computed with the aid of the integral image.
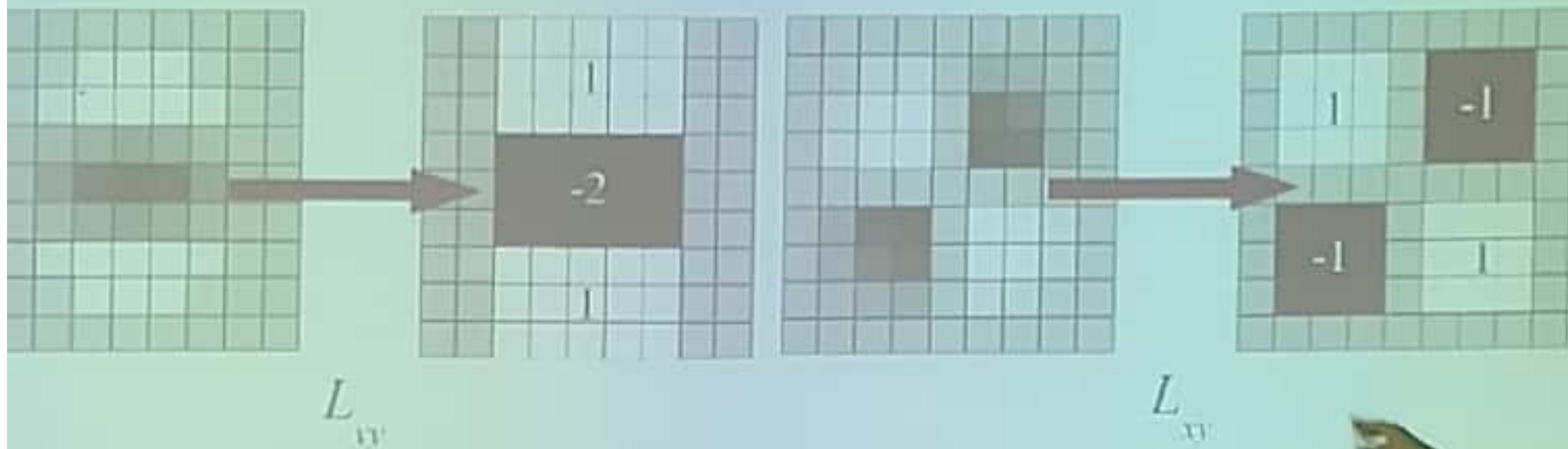
Detection

- Hessian-based interest point localization

$$H = \begin{bmatrix} L_{xx} & L_{xy} \\ L_{xy} & L_{yy} \end{bmatrix}$$

- $L_{xx}(x,y,\sigma)$ is the **Laplacian of Gaussian** of the image
- It is the convolution of the *Gaussian* second order derivative with the image
- Lindeberg showed Gaussian function is optimal for scale-space analysis
- This paper argues that Gaussian is overrated since the pro   that no new structures can appear while going to lower resolution is proven in 2D case
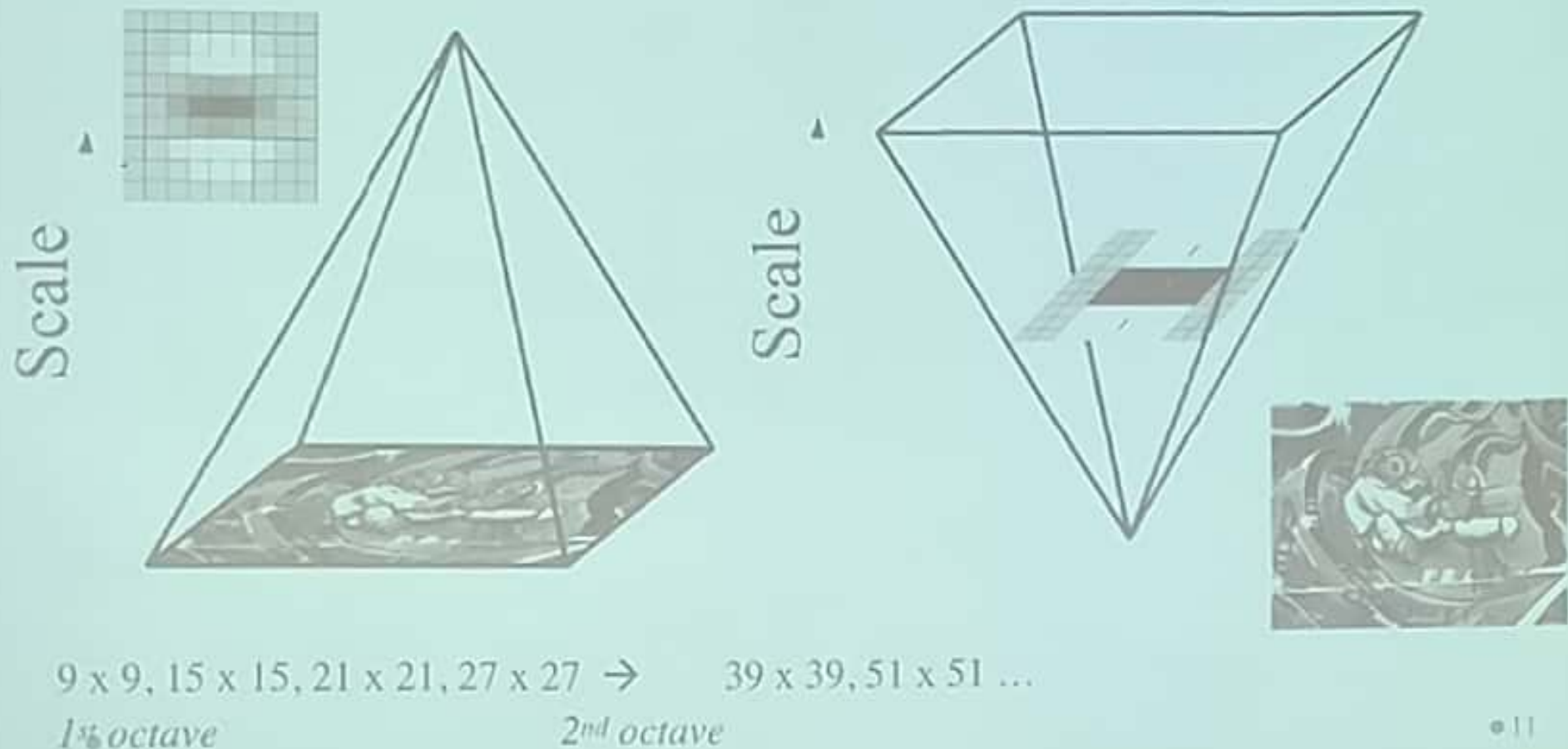
9

Detection

- Approximated second order derivatives with box filters (mean/average filter)

L_{yy} L_{xy}

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Detection

- Scale analysis with constant image size

9 x 9, 15 x 15, 21 x 21, 27 x 27 →   39 x 39, 51 x 51 ...

1ᵗ octave   2ⁿᵈ octave

Feature Description

Interest point *descriptor*:

- Divide window into 4x4 (16 subwindows)
- Compute Haar wavelet outputs
- Within each subwindow, compute

$$v_{subregion} = \left[\sum dx, \sum dy, \sum |dx|, \sum |dy| \right]$$

- This yields a 64-element descriptor

(Only implement USURF – no rotation)

Orientation Computation

- A window rotates around the origin that is 60 degrees wide

- Add up the responses within the window as the vector's length

- Longest vector is the interest point's orientation

Matching

- **Fast indexing through the sign of the Laplacian for the underlying interest point**

The sign of trace of the Hessian matrix

$$\text{Trace} = L_{xx} + L_{yy}$$

→ can do match

→ can do match

→ not match

matching