281 Live Session

Week 7 — 2023/2/22

Agenda

Note on Assignment 4 parameters

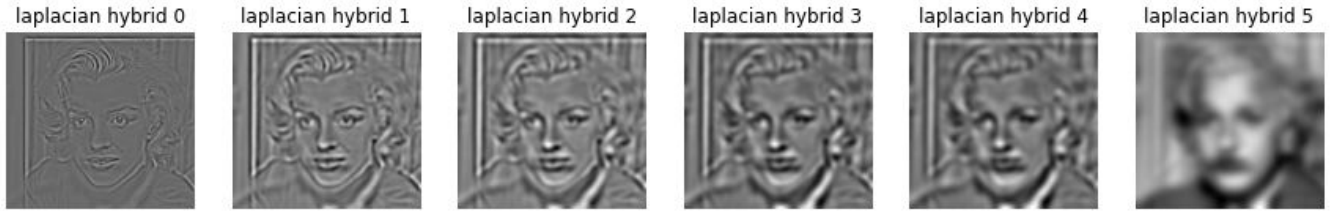
Review of Pyramids, Edges, and Features

Practical applications of Edge Detection

Group Exercise on Blending

Notes on Assignment 4

1. Default parameters for part 1 and part 2 don't match, you need to adjust parameters of Gaussians in part 1 to match stack levels in part 2.



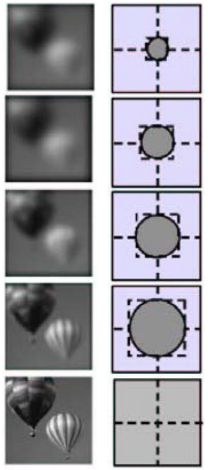
2. Normalization in part 2 is for **visualization** only. Do not normalize before combining your stack levels!

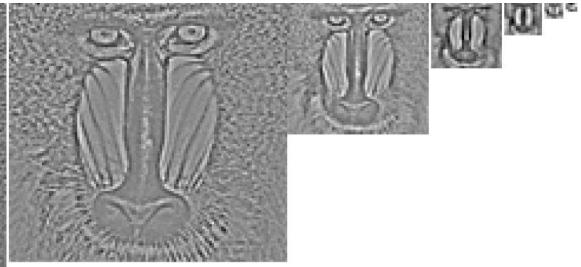
3. Remember that small-sized output images are effectively low-pass images.

Discussion Questions

- What is the difference between an image pyramid vs an image stack?
- Explain the difference between pre-processing and feature extraction
- Why might we use keypoints vs histograms vs filters?
- What information is encoded in a HOG feature vector?
- How can we modify features to make them more robust?
- What are the trade-offs of larger feature vectors?

Image Pyramids vs Stacks





Steps for Feature Extraction

(1) Check & clean up the raw data
(e.g. incorrect labels, corrupted images)

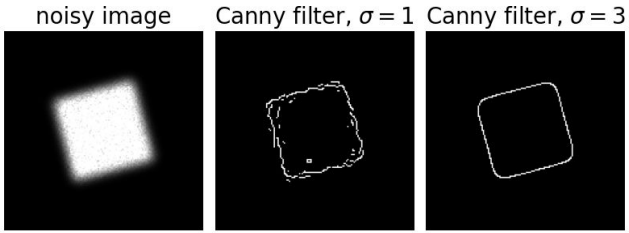
(2) Pre-process the images
(e.g. blurring, aligning, normalizing, etc – filtering out unhelpful artifacts)

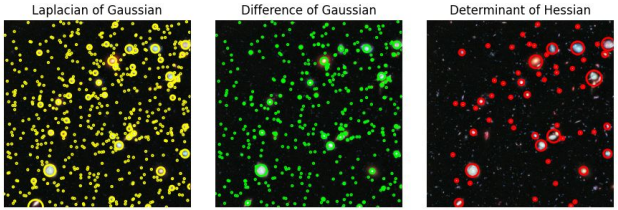
(3) Extract the features
(e.g. keypoints, histograms, or filters)

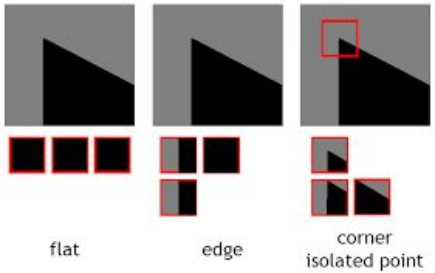
Types of Image Features

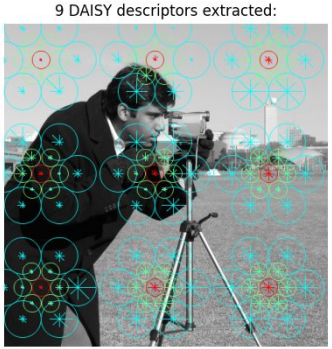
- Keypoints (e.g. corners, often used for localization)
- Histograms (for comparing broad color / luminance trends)
- Filter responses (for edge detection or template matching)

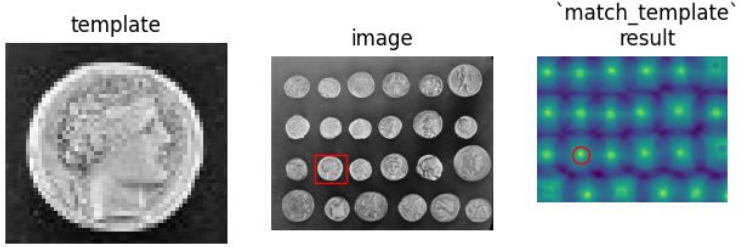
Example Features







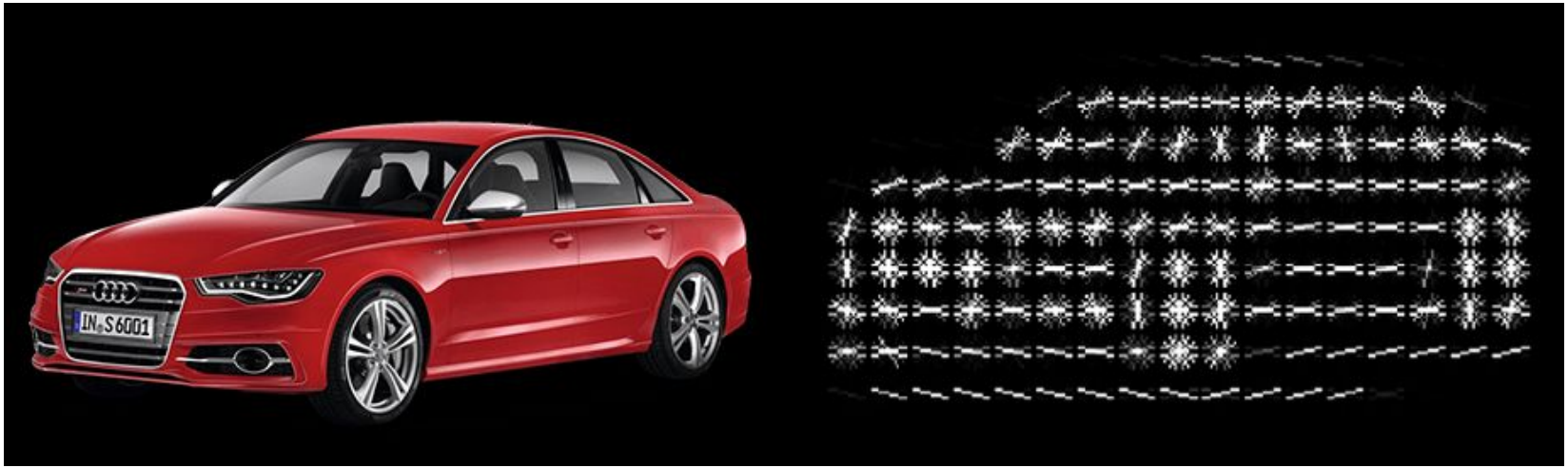




Sources: scikit-image.org, cs.ucsb.edu

Histogram of Oriented Gradients (HOG)

Good for canonical shapes, but cross-image alignment is key



Source: analyticsvidhya.com

Choosing Appropriate Image Features

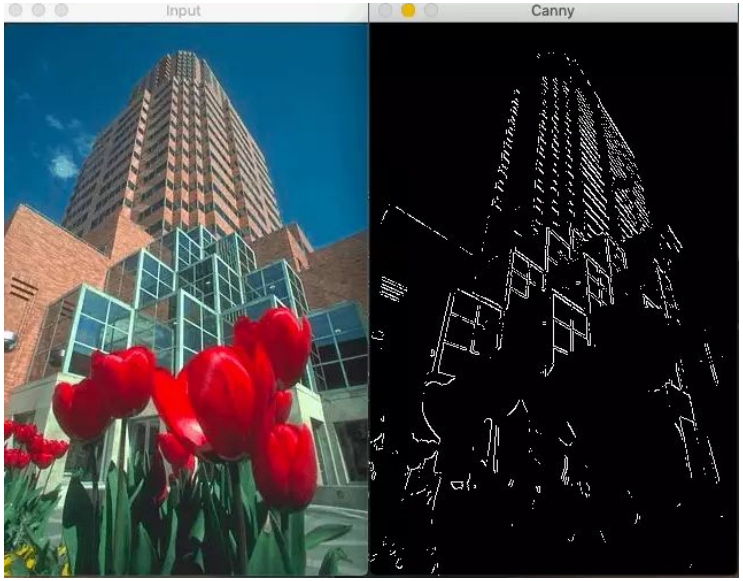
Robust Feature Characteristics

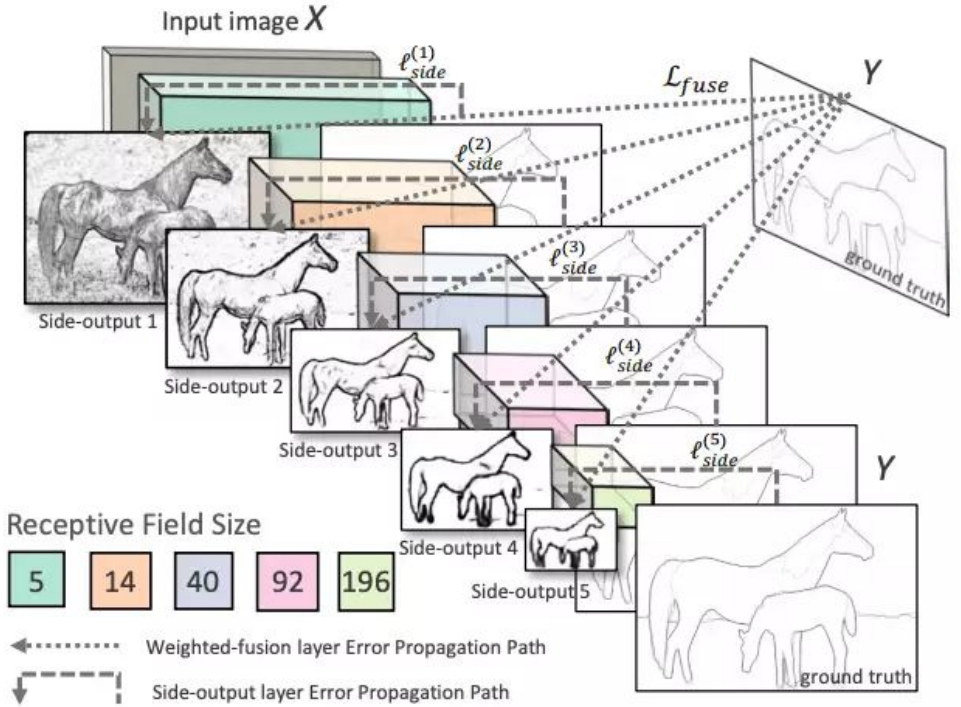
- Corners (stable localization)
- Multiscale (blur/scale invariance)
- Normalization (lighting invariance)
- Transformation to canonical representation (rotation invariance)

Trade-Offs for Larger Feature Vectors

- Speed / memory cost
- High dimensionality makes distances less meaningful
- Goal: alignment between dataset variance and feature vector variance

Benefits of Multi-Scale Features





Source: cv-tricks.com/opencv-dnn/edge-detection-hed

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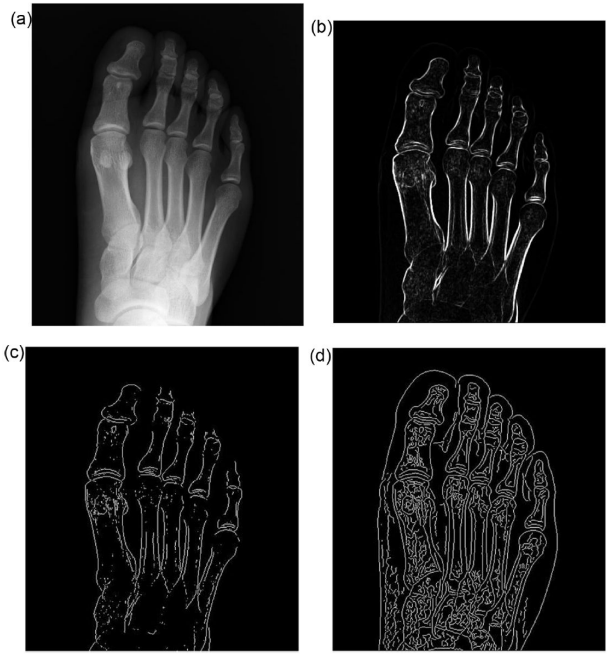
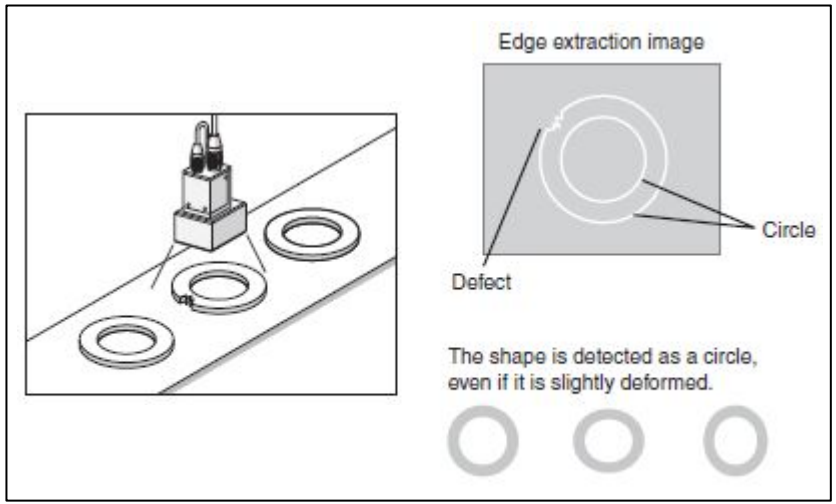
Edge Detection Applications

Original Thresholded Contrast Enhanced



Source: Vaghefi, Ehsan, et al. "Detection of smoking status from retinal images; a Convolutional Neural Network study." *Scientific reports* 9.1 (2019): 1-9.
Lin, Wei-Chun, and Jing-Wein Wang. "Edge detection in medical images with quasi high-pass filter based on local statistics." *Biomedical Signal Processing and Control* 39 (2018): 294-302.

Edge Detection Applications



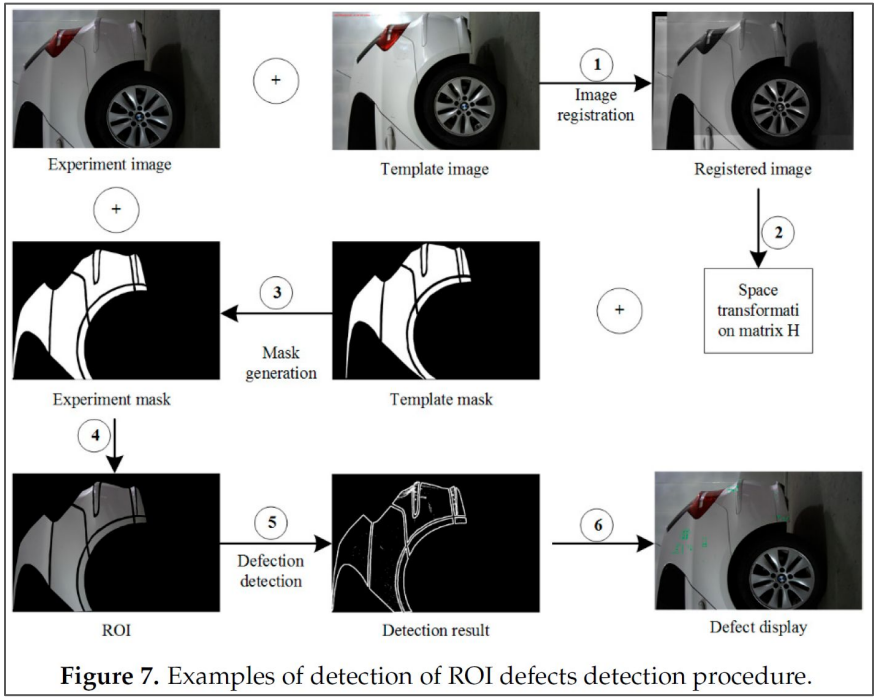


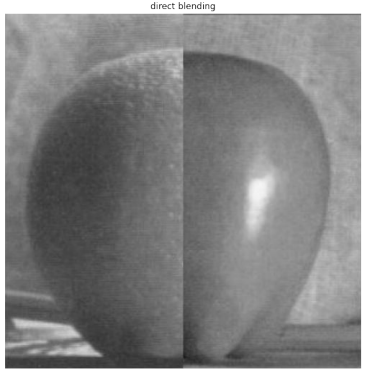
Figure 7. Examples of detection of ROI defects detection procedure.

Source: www.ia.omron.com/support/guide/44/introduction.html

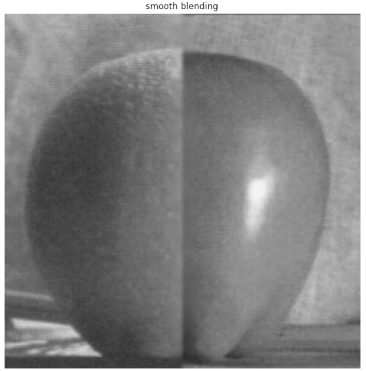
Zhou, Qinbang, et al. "An automatic surface defect inspection system for automobiles using machine vision methods." *Sensors* 19.3 (2019): 644.

Group Exercise – Blending

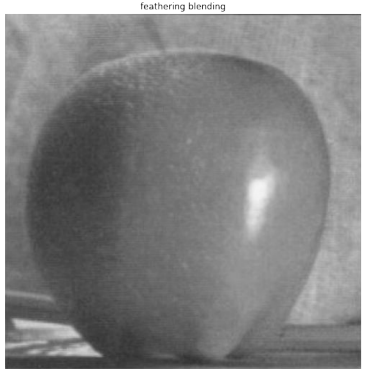
direct blending



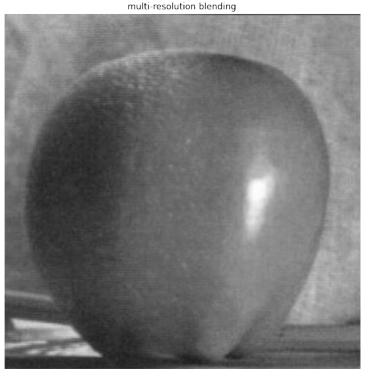
smooth blending



feathering blending



multi resolution blending



Upcoming ToDo's

Assignment 4 (Due Feb 27th)

Final project proposal (Due Mar 13th)

Watch Async lectures for Unit 7

Additional resources on CNN feature extraction:

https://www.3blue1brown.com/lessons/neural-networks