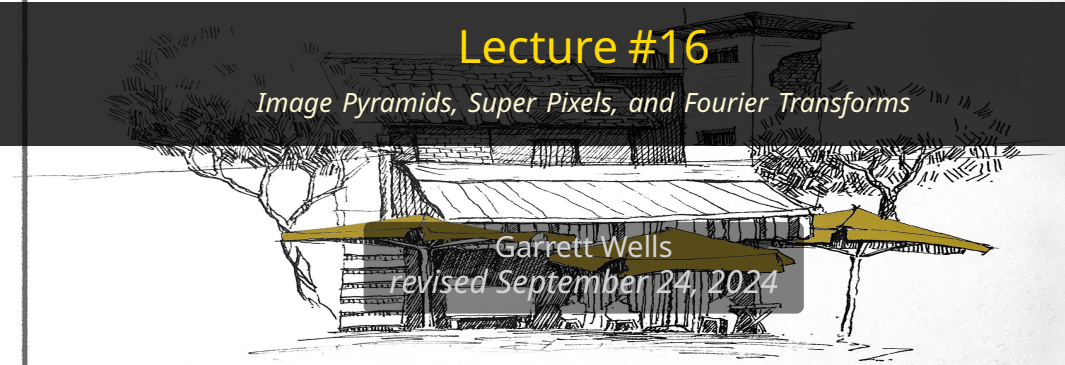
Lecture #16

Image Pyramids, Super Pixels, and Fourier Transforms



Garrett Wells

revised September 24, 2024

Table of Contents I

Table of Contents I

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Review

Super Pixels

Image Pyramids
Gaussian Pyramid
Laplacian Pyramid

Fourier Transforms

Review

Motion Detection

- Motion Size Estimation
- Motion Localization
- Motion Reporting/Visualization

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Super Pixels

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- Typically uses a clustering algorithm

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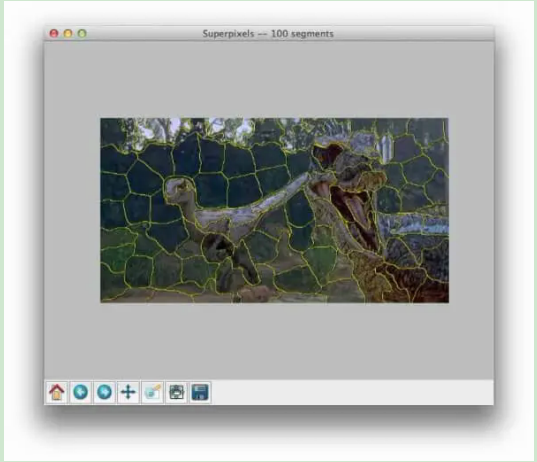
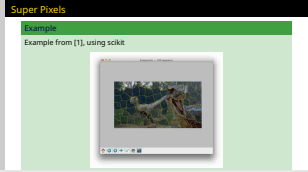
Super Pixels

Example

Example from [1], using scikit





Super Pixels

Benefits:

1. Computational Efficiency
2. Perceptual Significance
3. Oversegmentation
4. Graphing

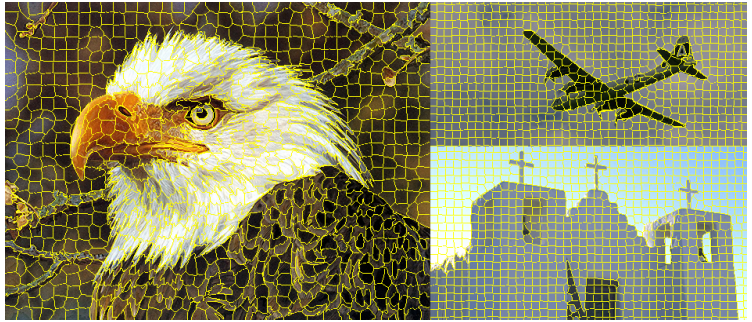


Figure: OpenCV Docs Example [2]

Super Pixels
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Figure: OpenCV Docs Example [2]

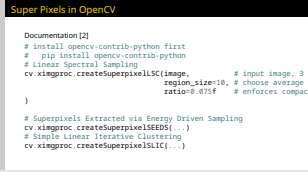
1. reduces the complexity of the image…
2. pixels grouped together by due to commonalities such as color or texture patterns
3. *Oversegmentation* means that important boundaries in the image are found, but some may be excessive. This is beneficial, as it means no pixels are lost.
4. Instead of constructing graphs which are thousands of pixels, we can graph between super pixels which already contain connected/related pixels. Much more efficient.

Super Pixels in OpenCV

Documentation [2]

```
# install opencv-contrib-python first
#   pip install opencv-contrib-python
# Linear Spectral Sampling
cv.ximgproc.createSuperpixelLSC(image,           # input image, 3
                                region_size=10, # choose average
                                ratio=0.075f    # enforces compac
)

# Superpixels Extracted via Energy Driven Sampling
cv.ximgproc.createSuperpixelSEEDS(...)
# Simple Linear Iterative Clustering
cv.ximgproc.createSuperpixelSLIC(...)
```

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  - object detection
  - upscaling/downscaling an image

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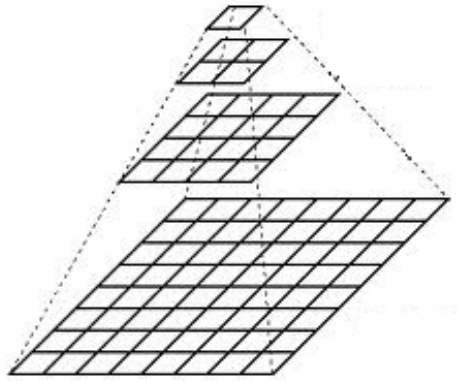
- Creates a “pyramid” of images at different resolutions [3]
- Highest resolution at bottom, lowest on top
- Different Construction Methods:
  - Gaussian
  - Laplacian



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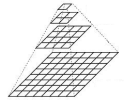

Gaussian Pyramid

Pyramid Down Algorithm:

1. Start with current resolution, $M \times N$
2. Construct next "Octave" (image with $1/4$ current resolution)
   - 2.1 Allocate image with dimensions, $M/2 \times N/2$.
   - 2.2 Fill each pixel in Octave by sampling 5 pixels from level below with Gaussian weights.
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Gaussian Pyramid in OpenCV

```
output_img = cv.pyrDown(src,             # input image
           dstsize=Size(),               # output img size
           borderType=cv.BORDER_DEFAULT # how to fill in edges
)
# same parameters here
cv.pyrUp(...)
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Laplacian Pyramid

- Formed from Gaussian pyramids
- Produces edge image
- Formed by taking difference between current level in Gaussian, and the expanded upper level of Gaussian
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Fourier Transforms

- Image is composed of signals
- Pixel values map to frequencies [4]
- Applications
  1. Filtering by frequency
  2. Edge Detection
  3. Blurring/Sharpening
  4. Rotation
  5. *etc.*

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Fourier Transforms in OpenCV

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cv.dft(src,            # input image/array 1D or 2D
       flags=0,        # transformation flags
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[2] “OpenCV: Superpixels,” (), [Online]. Available: https://docs.opencv.org/3.4/df/d6c/group__ximgproc__superpixel.html (visited on 09/24/2024).

[3] “OpenCV: Image Pyramids,” (), [Online]. Available: https://docs.opencv.org/4.x/d5/d0f/tutorial_js_pyramids.html (visited on 09/24/2024).

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[1] A. Rosebrock, “Segmentation: A SLIC Superpixel Tutorial using Python,” PyImageSearch. (Jul. 28, 2014), [Online]. Available: https://pyimagesearch.com/2014/07/28/a-slic-superpixel-tutorial-using-python/ (visited on 09/24/2024).

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Bibliography II

[4] “OpenCV 3 Image Fourier Transform : OpenCV FFT & DFT - 2020,” (), [Online]. Available: https://www.bogotobogo.com/python/OpenCV_Python/python_opencv3_Image_Fourier_Transform_FFT_DFT.php (visited on 09/24/2024).

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