SYDE 671 Advanced Image Processing

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Assignment 2 - Questions Part

1 Instructions

- This assignment has 1 exercise and 4 questions .
- The answers to this document are to be submitted as a part of one Jupyter notebook file only.
- Feel free to include images and equations and comment on both your code and results meticulously.

2 Exercice

Take a look at the webcam fourier decomposition demo code included. Run it with a webcam.
The file contains five parts for you to explore. You'll get to see the amplitude and phase of the images as well as the reconstructed image from them.

- Part 0: Scanning the basis and observing the output image.
- Part 1: Reconstructions from different numbers of basis frequencies
- Part 2: Replacing amplitude and phase with that from a different image.
- Part 3: Replacing amplitude and phase with that from a noise image.
- Part 4: Manipulating the amplitude and phase images.

Uncomment the different parts and explore the camera feed decomposition! Include the results of your experimentation, e.g., two-to-three screenshots of what you discover and discuss them. This will be graded for completeness and not correctness. For privacy concerns you don't have to take pictures of yourself, your pet or any object/book works.

3 Questions

Q1: Imagine we wished to find points in one image which matched to the same world point in another image—so-called feature point correspondence matching. We are tasked with designing an image feature point algorithm which could match world points in three pairs of images(see below). Please use the included python script **Harris_detector.py** to find corners using Harris corner detection. Discuss the differences in the returned corners (if any) for each image pair and what real world phenomena or camera effects may have caused these differences. Then discuss which real world phenomena and camera effects might cause us problems when matching these features. Please provide at least

one problem per pair.
The pairs are:

- Pair 1: Chase1.jpg - Chase2.jpg
- Pair 2: LaddObservatory1.jpg - LaddObservatory2.jpg
- Pair 3: RISHLibrary1.jpg - RISHLibrary1.jpg

Q2: In the Harris corner detector, what do the eigenvalues of the 'M' second moment matrix represent? Discuss both how they relate to image intensity and how we can interpret them geometrically.

Q3: Given a feature point location, the SIFT algorithm converts a 16×16 patch around the feature point into a 128×1 descriptor of the gradient magnitudes and orientations therein. Write pseudocode with matrix/array indices for these steps.

Notes: Do this for just one feature point at one scale; ignore the overall feature point orientation; ignore the Gaussian weighting; ignore all normalization post-processing; ignore image boundaries; ignore sub-pixel interpolation and just pick an arbitrary center within the 16×16 for your descriptor. Please just explain in pseudocode how to go from the 16×16 patch to the 128×1 vector. A pseudocode is **NOT** a code that is meant to compile and run, rather a blueprint of the code. Its a mixture between english words and some coding structure.

```
# You can assume access to the image, x and y gradients, and their
                                    magnitudes/orientations.

image = imread('rara.jpg')
grad_x = filter(image, 'sobelX')
grad_y = filter(image, 'sobelY')
grad_mag = sqrt( grad_x .^2 + grad_y.^2 )
grad_ori = atan2( grad_y, grad_x )

# Takes in a feature point x,y location and returns a descriptor
def SIFTdescriptor(x, y)
    descriptor = zeros(128,1)


    return descriptor
```

Q4: **a)** Explain the difference between the Euclidean distance and the cosine similarity metrics between descriptors. What might their geometric interpretations reveal about when each should be used?
b) Given a distance metric, what is a good method for feature descriptor matching and why?