Homework 2 Questions

Instructions

- 2 ethical implications questions, which will be expanded on in discussion sections.
- 1 exercise graded for completion only.
- 3 graded technical questions.
- Write code where appropriate.
- Feel free to include images or equations.
- Please make this document anonymous.
- This assignment is **fixed length**, and the pages have been assigned for you in Gradescope. As a result, **please do NOT add any new pages**. We will provide ample room for you to answer the questions. If you *really* wish for more space, please add a page *at the end of the document*.
- **We do NOT expect you to fill up each page with your answer.** Some answers will only be a few sentences long, and that is okay.

Ethical Implications

Q1: One use of local feature extraction and matching is fingerprint recognition. Fingerprint recognition, like face and iris recognition, makes use of biometric data, or measurements of human features. Fingerprint recognition is convenient as a mechanism to unlock devices without needing to remember yet another password, and is more secure than passwords in certain ways. However, the collection of biometric data also raises unique privacy and security concerns.

Please find a news or opinion article discussing pros and cons of using biometric data and link it here. Discuss 3 points in the article that you agree and/or disagree with. What are three groups of people that could be impacted by the use of biometric data and how?

A1: Your answer here.

Only A1 should be on this page

Q2: Brown University decides to use biometric data instead of requiring passwords for the login system. For your CS1430 final project, you are put in charge of developing the authentication system by expanding on your local feature matching project. All users will be required to use your biometric authentication system to log into their Brown accounts.

Please discuss and justify your design choices for:

- What information to provide to users about the system
- What kind of biometric data to use (fingerprint, iris, facial, etc.)
- How to store that information

Remember to consider accessibility, privacy, and security in your responses. This article will be helpful for responding to the final question. Please link to any additional sources you use to inform your decisions.

A2: Your answer here.

Exercise

E1: Let's look again at the webcam Fourier decomposition demo which James showed in class. Let's run it in our CSCI 1430 virtual environment *preferably on a computer with a webcam*, from within the 'questions' directory.

```
$ python liveFFT2.py
```

This file contains five parts for you to explore and see the amplitude image, the phase image, and the effect of the reconstructed image.

- 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! Please include the results of your experimentation, e.g., two-to-three screenshots of what you discover. We'll be grading for completion, not correctness. *Note:* For anonymous grading, try not to put yourself in the camera frame. Show your favourite vector calculus book, wear a mask, use your cat, etc. Extra credit for creative effort.

Exercise Results

Please include images of your results from the exercise here, e.g., two-to-three screenshots of your findings.

Extra space

Technical 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 the following three pairs of images.

RISHLibrary: One Two — *Chase:* One Two — *LaddObservatory:* One Two

Please use the included python script `plot_corners.py` to find corners using Harris corner detection for each image above.

For each pair, discuss the differences in the returned corners (if any), and what aspects of the images may have caused these differences. Then discuss what real world challenges exist in matching features between images.

A1 (a): Answer for RISHLibrary pair

Only A1(a) should be on this page

A1 (b): Answer for Chase pair

A1 (c): Answer for LaddObservatory pair

Q2: The Harris Corner Detector is commonly used in computer vision algorithms to find interest points from which to extract stable features for image matching.

How do the eigenvalues of the 'M' second moment matrix vary with local image brightness, and how might we interpret the eigenvalues geometrically (think 'shape')?

A2: Your answer here.

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

Notes: Do this for just one interest point at one scale; ignore the overall interest 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 feature descriptor. Please just explain in pseudocode how to go from the 16×16 patch to the 128×1 vector. You are free to simplify the gradient computation.

A3: Your answer here.

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

    return descriptor
```

Feedback? (Optional)

Please help us make the course better. If you have any feedback for this assignment, we'd love to hear it!