Homework 3

CSE 402: Biometrics and Pattern Recognition
Instructor: Dr. Arun Ross
Due Date: November 21, 2022 (11:00pm)
Total Points: 60

Note:

□ You are permitted to discuss the following questions with others in the class.

□ However, you *must* write up your *own* answers to these questions. Any indication to the contrary will be considered an act of academic dishonesty.

□ A neatly typed report with detailed answers is expected. The report must be uploaded in D2L in PDF format.

□ All outputs, such as graphs and images, must be included in the report.

□ Any code developed as part of the assignment must be (a) included as an appendix in the report, as well as (b) archived in a single zip file and uploaded in D2L.

□ Include a bibliography at the end of the report indicating the resources that you used (e.g., URL, scientific articles, books, etc.) to complete this homework.

□ Please submit the report (PDF) and the code (Zip file) as two separate files in D2L.

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1. [15 points] Consider a set of 1000 2-dimensional points here. Use Matlab (or any other software) to perform the following tasks:

   (a) Compute and report the mean vector of these points.

   (b) Compute and report the covariance matrix of these points.

   (c) Compute and report the eigen-vectors and eigen-values of the covariance matrix. There should be two eigen-vectors and two eigen-values.

   (d) Plot the eigen-vectors (along with the 1000 points) in a 2D graph and display the graph. Note that the eigen-vectors will have to originate from the mean of the points. The length of each vector should be in proportion to its corresponding eigen-value.

2. [15 points] One of the *model-based* face recognition methods described in the literature is Elastic Bunch Graph Matching (EBGM). The EBGM technique is discussed in pages 122 - 124 of the textbook. More details about this algorithm can also be found here. In the context of the EBGM algorithm, answer the following questions:

   (a) What are fiducial points?

   (b) What are Gabor Jets?

   (c) What is a Face Bunch Graph (FBG)?

   (d) How are two face images compared using the EBGM algorithm?

   (e) What do you think are some of the limitations of the EBGM method for face recognition?

3. [10 points] Describe the three different levels at which facial characteristics can be organized from a biometrics perspective. Explain the types of features in each level and the role of these features in face recognition.

4. [10 points] There are a number of face matching and face analysis applications readily available. For example, Cloud Vision AI, Betaface, PimEyes, Luxand, BioID, Face2Gene, etc.

   (a) Experiment with at least two of these applications, and include in your report the input(s) that you gave and the output(s) that was/were produced by each application.

   (b) What are the pros and cons of deploying face recognition systems in public spaces? What are some of the ethical aspects of utilizing face recognition in general? Explain your answer in detail. (Note that face *recognition* is different from general face *analytics*).

5. [10 points] Using the face images that you collected in class, answer the following. You may collect additional selfies of your face, if needed.

   (a) Show examples of face images exhibiting different types of intra-class variations. Explain the nature of the intra-class variations.

   (b) Which portions of the face are more resilient to changes in expression and why?

   (c) Take one of the frontal face images, convert it to grayscale and convolve the grayscale image with **average filters** of the following dimensions: 3×3, 15×15, 45×45. Show the input image and the output images. Explain the differences in output pertaining to the 3 filters.

   (d) From your perspective, what are some of the challenges in performing face recognition using selfies.
