CS-4243, S 2023-1, Coursework 2

Coursework Description

- This coursework consists of two parts, comprising five questions, and contributes to a total of 9 CA marks out of the final 100-mark evaluation.
    - Part 1: Three multiple-choice questions (MCQs), each worth 2 marks (6 marks in total). Each MCQ has a **single** correct answer. There is no penalty for incorrect answers. Please select the **best and most accurate** option.
    - Part 2: Two long-answer questions, worth 1.5 CA mark each (3 marks in total).
- The coursework will be submitted through a Canvas Quiz. The CW2 quiz will be available soon. Different parts and questions in the quiz have been appropriately categorized. For instance, Part 1 consists of MCQs, and Part 2 comprises essay questions where you can include images or attach files to your responses.
- The CW2 quiz will be accessible in the Canvas "Quizzes" folder, allowing you to submit your coursework.
- The coursework is due on **Sunday, 22/10/2023, 11:59 pm.**
- Goodluck, my friends.

Part 1. MCQs (2 marks each)

1. Consider collage1.bmp and 20230324_105524gl.jpg as your test images. Both images should be gray level. We call them a and b here, consecutively. Separate a 512x512 patch of each from <0,0> to <512,512> (Python standard), we call them a5 and b5. Compute the GLCM matrix of a5 and b5 with d=3, and Θ=0 and 90. Lets call them $GLCM_{3,0}^{a5}$, $GLCM_{3,90}^{a5}$, $GLCM_{3,0}^{b5}$, $GLCM_{3,90}^{b5}$ separately. Regarding the f_1 or GLCM energy function, compute f_1(.) for all four GLCM matrices, and select the best answer below.
    a. $f_1(GLCM_{3,0}^{a5}) < f_1(GLCM_{3,0}^{b5}) < f_1(GLCM_{3,90}^{a5}) < f_1(GLCM_{3,90}^{b5})$, this test shows that a5 texture is coarser than b5 texture.
    b. $f_1(GLCM_{3,0}^{a5}) > f_1(GLCM_{3,90}^{a5})\ and\ f_1(GLCM_{3,0}^{b5}) < f_1(GLCM_{3,90}^{b5})$, this test shows that in a5, the strength and presence of horizontal patterns is higher than the vertical patterns, whereas in b5 the strength and presence of vertical and horizontal patterns are not significantly different.
    c. $f_1(GLCM_{3,0}^{a5}) < f_1(GLCM_{3,90}^{a5})\ and\ f_1(GLCM_{3,0}^{b5}) > f_1(GLCM_{3,90}^{b5})$, this test shows that in a5, the strength of vertical patterns is higher than the horizontal patterns, whereas in b5 the strength of vertical and horizontal patterns are comparable.
    d. $f_1(GLCM_{3,0}^{a5}) > f_1(GLCM_{3,0}^{b5}) > f_1(GLCM_{3,90}^{a5}) > f_1(GLCM_{3,90}^{b5})$, this test shows that a5 texture is coarser than b5 texture.

2. Use the 9-filtered Law's filter bank (see lab6_7_for_students.ipynb notebook), and IMG_0054_1024bw.bmp , and 6ae-007_1024_bw.bmp as your reference images, indicated as c and d here. Lets indicate the Law's filters as f_0 to f_8 and power of each filtered image as $P_{f_i}^{image}$, for *image* in [c,d] and *i* in [0 to 8]. Now, select the best answer below.
   a. $P_{f0}^{c} > P_{f0}^{d} > P_{f8}^{c} > P_{f5}^{c} \gg P_{f8}^{d} > P_{f5}^{d}$, a comparison between Law's f_1 to f_8 filter responses suggests that more lines and edges can be seen in c compared to d.
   b. $P_{f0}^{c} > P_{f0}^{d} > P_{f8}^{c} > P_{f5}^{c} \gg P_{f8}^{d} > P_{f5}^{d}$, but no conclusion can be made based on the comparison of Laws' filter responses on c and d.
   c. $P_{f0}^{c} > P_{f0}^{d} > P_{f1}^{c} > P_{f1}^{d} > P_{f2}^{c} > P_{f2}^{d}$, but no conclusion can be made based on the comparison of Laws' filter responses on c and d.
   d. $P_{f0}^{c} > P_{f0}^{d} > P_{f1}^{c} > P_{f1}^{d} > P_{f2}^{c} > P_{f2}^{d}$, a comparison between Law's f_1 to f_8 filter responses suggests that more lines and edges can be seen in c compared to d.

3. Consider images 34.jpg , 68.jpg, indicated as x and y consecutively in this question. Convert both to gray level firstly. Apply lowpass and highpass filters, h_{lp} and h_{hp}, mentioned below, on them. Then compute the power of the filtered images and show them as P_{lp}^{x} , P_{hp}^{x} , P_{lp}^{y} , P_{hp}^{y}. Then down sample (or zoom-out) x and y to 25% of the original size. Utilize Open CV resize function and its INTER_LINEAR option. Resulting images are xd and yd. Repeat the process for xd and yd and obtain P_{lp}^{xd} , P_{hp}^{xd} , P_{lp}^{yd} , P_{hp}^{yd} . Then select the best answer below.

$$h_{lp} = \begin{bmatrix} 0.111 & 0.111 & 0.111 \\ 0.111 & 0.111 & 0.111 \\ 0.111 & 0.111 & 0.111 \end{bmatrix} \qquad h_{hp} = \begin{bmatrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{bmatrix}$$

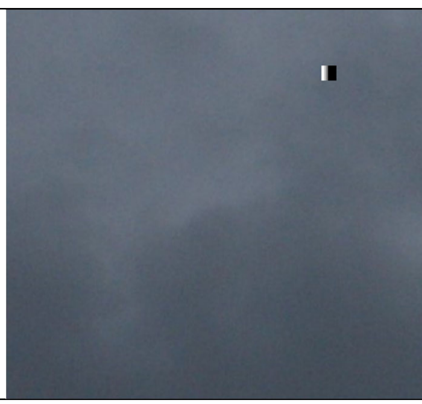
   a. Regarding the $\frac{P_{hp}^{*}}{P^{*}}$ and $\frac{P_{lp}^{*}}{P^{*}}$, $(* \in \{x, y, xd, xy\})$ ratios, it can be concluded that while the highpass filter performs well, the lowpass filter cant carry out its task.
   b. Regarding the $\frac{P_{hp}^{*}}{P^{*}}$ and $\frac{P_{lp}^{*}}{P^{*}}$, $(* \in \{x, y, xd, xy\})$ ratios, it can be concluded that while the lowpass filter performs well, the highpass filter cant carry out its task.
   c. Down-sampling has not changed the $\frac{P_{hp}^{*}}{P^{*}}$ and $\frac{P_{lp}^{*}}{P^{*}}$, $(* \in \{x, y\})$ ratios significantly, compared to the $\frac{P_{hp}^{*}}{P^{*}}$ and $\frac{P_{lp}^{*}}{P^{*}}$, $(* \in \{xd, yd\})$.
   i.e., $\frac{P_{lp}^{x}}{P^{x}} \approx \frac{P_{lp}^{xd}}{P^{xd}}, \frac{P_{lp}^{y}}{P^{y}} \approx \frac{P_{lp}^{yd}}{P^{yd}}, \frac{P_{hp}^{x}}{P^{x}} \approx \frac{P_{hp}^{xd}}{P^{xd}}, \frac{P_{hp}^{y}}{P^{y}} \approx \frac{P_{hp}^{yd}}{P^{yd}}$, (≈ means almost equal)
   d. Before down-sampling, for both images x and y, the $\frac{P_{lp}^{*}}{P^{*}}$ is around 99%, while $\frac{P_{hp}^{*}}{P^{*}}$, $(* \in \{x, y\})$ is only a few percent. However, after down-sampling, it changes. In particular for yd, $\frac{P_{hp}^{yd}}{P^{yd}}$ will be much bigger than $\frac{P_{hp}^{y}}{P^{y}}$.

Part 2. Long answer Question (3 marks, 1.5 each)

4. Specify how optical flow can be used to determine: (max word length=500)
    a. Mutual velocity of an observer and an object
    b. The focus of expansion
    c. Distance of a moving object from the observer
    d. Possible collision of the object with an observer and time of collision

5. Consider two video frames below, fr11.png and fr12.png. Develop a program to estimate the velocity of the motion object in those frames based on vertical edges detection. The points are:
    e. Frames are 2d vertical views.
    f. The time interval between fr11 and fr12 is 2.5 seconds.
    g. The real size of each pixel on those frames is 5x5 cm.
    h. Find the vertical edges with highest strength on both frames. You may use the 1st or 2nd derivatives.
    i. Find the top pixel of that edge as the interest points.
    j. Try to compute the velocity of the object based on that in m/s.
    k. What will be the real-world applications of this algorithm?

You have to submit your code, the displacement vector obtained shown on one of the frames, and your answers to bullets j and k above.

	
fr11.png	fr12.png

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