CS 282
Programming Assignment 1
OpenCV Exercises
Image Enhancement

Pros Naval

Individual Submissions
Due: 12 noon of Feb 16, 2026

Write OpenCV programs with the following specs:
(Note: All codes should use OpenCV 4.11)

1. Program that performs the computations described below:

   (a) Select a negative floating-point number. Take its absolute value, round it, and then take its ceiling and floor. Print the results to screen.

   (b) Generate a 3×4 matrix whose elements are random integers. Print the matrix.

   (c) Declare matrix variables A, B and integer variable c within OpenCV. Assign them with the following values:

$$
\begin{aligned}
A &= \begin{pmatrix} (6,0,2) & (2,6,5) & (9,7,1) \\ (1,6,4) & (5,4,9) & (6,9,2) \\ (3,5,9) & (5,3,7) & (8,3,3) \end{pmatrix} \\
B &= \begin{pmatrix} (9,1,9) & (7,0,5) & (2,0,3) \\ (9,2,3) & (4,3,6) & (0,2,9) \\ (7,2,6) & (0,3,8) & (4,2,1) \end{pmatrix} \\
c &= 0.7 \\
d &= 0.55
\end{aligned}
$$

   Compute the following:

   i. $cA + (1-c)B + d$

   ii. A^{-1} (using SVD)

   iii. eigenvalue of B

   iv. solve the matrix equation $Ax = b$ where

$$
b = \begin{pmatrix} (3,5,5) \\ (7,2,8) \\ (4,1,6) \end{pmatrix}
$$

and print the results.

(d) Create a 2D matrix with three channels of type byte and size 100-by-100 and set all values to zero. Draw a red rectangle between with corners $(30, 10)$ and $(60, 40)$. Display this image.

(e) Copy the red channel in (d) above into another matrix for display as grayscale image.

2. Reads and displays a video and is controlled by a slider and button. The slider controls the position within the video from start to end in 10 increments and the button controls pause/unpause. Label them both. The program will prompt the user to type in the filename of the video.

3. Write code that reads in and displays an image. When the user clicks on the image, display the mouse pointer coordinates and the corresponding pixel (blue, green, red) values and write those values as text to the screen at the mouse location.

4. Write code that continuously reads frames from your webcam, turns the result to grayscale, and performs Canny edge detection on the image. Display all three stages of processing as three different images in one window. (Hint: create another image of the same height but three times the width as the video frame. Copy the images into this by creating three new image headers that point to the beginning of and to one-third and two-thirds of the way into the image data.)

5. **Image Enhancement**
   Write code that performs image enhancement on the following images using the spatial domain operators we learned in class:

   (a) dental.gif

   (b) cells27.jpg

   (c) butterfly.gif

   (d) momandkids.jpg

   Which operations did you use and why ?

6. **Unsharp Masking in the Spatial Domain**
   Unsharp masking consists of blurring the original image and subtracting the blurred image from the original. We call the difference image as the ”mask”. The mask (or a fraction of it) is then added to the original.

   Write code for the filter described above and apply unsharp masking to the building.tif image. Compare the filtered image with the original. What do you see that are not seen in the original ? Are they really there or are they artifacts of the process ? Explain

7. **Translation and Rotation Properties of the 2D Fourier Transform**
   The translation property of the Fourier Transform is described by the following:

$$\mathcal{F}[f(x - x_0, y - y_0)] = \mathcal{F}(u, v)e^{-j2\pi(ux_0+vy_0)/M)}$$

$$f(x - x_0, y - y_0) = \mathcal{F}^{-1}[\mathcal{F}(u, v)e^{j2\pi(ux_0+vy_0)/M}]$$

   i.e., if the image is moved, the resulting spectrum undergoes a phase shift but the magnitude remains the same.

Rotation property is better illustrated using polar coordinates:

$$r = x\cos(\theta) \qquad c = y\sin(\theta) \tag{1}$$

$$u = \omega\cos(\alpha) \qquad v = \omega\sin(\alpha) \tag{2}$$

The Fourier Transform pair $f(x,y)$ and $\mathcal{F}(u,v)$ are thus written as $f(x,\theta)$ and $\mathcal{F}(\omega,\alpha)$ respectively. The follow property now becomes obvious:

$$f(x,\theta+\theta_0) = \mathcal{F}^{-1}[\mathcal{F}(\omega,\alpha+\theta_0)]$$

$$\mathcal{F}[f(x,\theta+\theta_0)] = \mathcal{F}(\omega,\alpha+\theta_0)$$

i.e. if an image is rotated by an angle θ_0, then $\mathcal{F}(u,v)$ is rotated by the same angle and vice versa.

Verify the above properties on the cameraman images (cameraman1.jpg to cameraman4.jpg). You must display the magnitude and phase of the Fourier spectrum of each. Compare them with the original image (cameraman1.jpg).

Deliverables

- OpenCV codes with comments. Specify what OS was used.
- Write up reporting your observations. Input and output images for 5 to 7 should be included.

The deadline for submission is **12:00 noon of February 16, 2026**. Email deliverables to `submit2pcnaval@gmail.com` with "[CS282: PA1 Submission] <Your Name>" on the subject line.