AI61201: Visual Computing with AI/ML

Programming Assignment 1: Working With Images Using OpenCV (20 Marks)

Due Date: *August 13 (by 9 PM IST)*

Instructions: *Complete the five tasks given, keeping the following points in mind:*

- *Implement the image operations from scratch (without using OpenCV library), and verify using OpenCV library functions.*
- *Vectorized implementations are possible for most operations, and using for or while loops to access individual pixels is strongly discouraged due to its inefficiency. You can use NumPy to perform the mathematical operations.*

Task 1: Color Space Conversion (3 Marks)

Convert an image from YUV to YCbCr color space using the provided conversion matrices. Implement the conversion without using OpenCV library functions. Verify the result using OpenCV. Use a_1_task_1.png as input.

Conversion Matrices

$$\begin{bmatrix} R \\ G \\ B \end{bmatrix} = \begin{bmatrix} 1.0 & 0.0 & 1.13983 \\ 1.0 & -0.39465 & 0.58060 \\ 1.0 & 2.03211 & 0.0 \end{bmatrix} \times \begin{bmatrix} Y \\ U \\ V \end{bmatrix} \qquad \begin{bmatrix} Y \\ Cb \\ Cr \end{bmatrix} = \begin{bmatrix} 0.299 & 0.587 & 0.114 \\ -0.168736 & -0.331264 & 0.5 \\ 0.5 & -0.418688 & -0.081312 \end{bmatrix} \times \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

Task 2: Logical Operation on Images (3 Marks)

Perform a logical XOR operation on two grayscale images. Implement the XOR operation manually without using library functions. Verify the result using OpenCV. Use a_1_task_2_a.png and a_1_task_2_b.png as inputs.

Task 3: Image Rotation (3 Marks)

Rotate a given image by varying the angle of rotation between 0° – 180° in increments of 45°. Implement the rotation manually without using OpenCV's rotation functions. Verify the result using OpenCV. Use a_1_task_3.png as input.

Task 4: Bit Plane Slicing (5 Marks)

Given two images A and B, hide the most significant bit plane of image B in one of the bit planes of image A, to generate image A’ such that A and A’ are visually identical. Use a_1_task_4_a.png as input A and a_1_task_4_b.png as input B. Which bit plane of

image A did you use for this purpose? Write your answer in a text cell with justification. You DO NOT have to verify using OpenCV, as there is no direct OpenCV implementation for this task. Instead, show the images A and A'. Also, submit the image A' as *<roll_number>_Task4_output.png.*

Task 5: Bicubic Interpolation (6 Marks)

Upsample an image by a factor of 4 for width and 4 for height using bicubic interpolation. Implement the interpolation manually without using OpenCV's interpolation functions. Verify the result using OpenCV. Use a_1_task_5.png as input.

Link to download the inputs for tasks

https://drive.google.com/file/d/1f5NA-cUQi8jav5b_RldXVeDAcdqQwK2q/view?usp=sharing

Submission Guidelines

1. *The content that you submit must be your individual work.*
2. *Submit your code in .py as well as in .ipynb file format. Both these file submissions are required to receive credit for this assignment*
3. *Ensure your code is well-commented and easy to follow. You can write your answers and explanations using text cells in the jupyter notebook files wherever required. For example, in Task 4, you need to state which bit plane you have chosen to replace, along with proper justification for your choice.*
4. *Submit output files wherever instructed. For example, it is needed to submit the output for task 5 in this assignment.*
5. *The files should be named as "<roll_number>_assignment_1". For example, if your roll number is 23AI91R01, the code the required file names will be 23AI91R01_assignment_1.py, 23AI91R01_assignment_1.ipynb and 23AI91R01_Task4_output.png. You should place all these files within a single zip file and upload it to Moodle as 23AI91R01_assignment_1.zip.*
6. *All submissions must be made through Moodle before the deadline. The submission portal will close at the specified time, and submissions via email would not be accepted.*

TA for this assignment: Raj Krishan Ghosh

If you have any queries regarding Assignment 1, please email at rajkrishanghosh@gmail.com