WorkShop6

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Instructions:

- The workshop can be completed **in groups (maximum of four members per group (recommended))**.
- All group members should work together, and they will receive the same mark.
- This workshop is worth 2.5% of the total course grade, and it will be graded out of 25 marks and evaluated through your written submission, as well as the lab demo as follows:
    - 25 marks (2.5% of the total course grade)
        - 15 out of 25 (60%): Blackboard submission
        - 10 out of 25 (40%): Lab demo during the lab session
- Please submit the submission file(s) through Blackboard. **Only one person must submit for the group; only the last submission will be graded**.
- During the lab demo, group members are ***randomly*** selected to explain the submitted solution.
- **Group members who do not present during the lab demo will lose the demo mark.**

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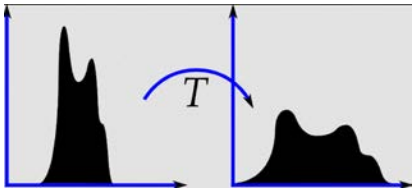
Part One: Description

This workshop is just to ensure that you can perform image enhancement transformations. Contrast enhancement is a common operation in image processing. It's a useful method for processing scientific images such as X-ray or satellite images. It is also useful to improve detail in photographs that are over or underexposed.

Contrast Enhancement for Grayscale Images

Histogram Equalization is an enhancement technique for general-purpose contrast manipulation. Histogram equalization transforms the gray levels of the input image and spreads them onto the available full range of gray levels so that the output image is of high contrast. Hence, histogram equalization effectively spreads out the most frequent intensity values, resulting in a better histogram distribution. This allows areas of lower local contrast to gain a higher contrast without affecting the global contrast. It has been proven that transforming the input image using a transformation function related to the probability density function of the gray levels of the input image would give an output image of uniformly distributed gray levels. Read more about histogram equalization on this Wikipedia page: Histogram equalization and from course lecture slides.



Contrast Enhancement for Color Images

Normally, color images are stored in RGB color space. At first glance, applying histogram equalization to a color image seems simple: just do it on each channel. However, applying histogram equalization separately on each channel of an RGB will probably destroy the balance of different color components and result in poor image quality. A solution to this problem is first to convert the image to a color space with a separate luminance channel, e.g. the HSL/HSV colour space or the YUV color, and then apply histogram equalization to the **luminance** or **value** channel. After that, we convert the image back to RGB color mode.

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Numpy Library (Necessary, because OpenCV uses it in the background) - Numpy help:

a) Python Numpy Tutorial (with Jupyter and Colab): https://cs231n.github.io/python-numpy-tutorial/

b) Learn NUMPY in 5 minutes - BEST Python Library! : https://youtu.be/xECXZ3tyONo

c) UCSB Numpy Tutorial: https://sites.engineering.ucsb.edu/~shell/che210d/numpy.pdf

d) Numpy Tutorial: A Simple Example-based Guide: https://stackabuse.com/numpy-tutorial-a-simple-example-based-guide/

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Part Two: Workshop Structure

Download the starter code "ws6.zip" for workshop3 from Blackboard

The workshop folder/directory structure is as follows:

- **code**/: directory contains files named as **question<x>.py**. For example, **question1.py**, …. you need to write your code in these python files.
- **data**/: directory contains the input images, videos or other data supplied with this workshop.
- **output**/: directory must be used to store your output from this workshop. Your output can be images, videos, or other file types.
- **zip_submission.py**: This Python file will be used by you to create a zip file containing your code and output. To generate the submission once finished, use the following command: "**python zip_submission.py**".
    - Note: **run this command inside the ws6 directory**
    - You must submit this Zip file with your pdf report through Blackboard.
- ***.py:** add any other supporting files you may need to complete your workshop to the **code** directory.

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Part Three: Perform Histogram Equalization on The Grayscale

Question 1. Write a code in **question1.py** file to do the following tasks:
Note: You can divide your code into several functions.

Step1. Read image "**seagrayscale.jpg**" from the data folder with option **cv2.IMREAD_GRAYSCALE**.
Step2. View the image on screen using **cv2.imshow**.
Step3. Now, compute histogram of the input image "**seagrayscale.jpg**". **Review the lecture slides for different ways to compute the histogram**.
Step4. At the top of your Python code make sure you imported the matplotlib library using
`import matplotlib.pyplot as plt`

Note: You can read more about the matplotlib library from this link: https://matplotlib.org/ . A complete tutorial with examples available at this link https://matplotlib.org/tutorials/.

Step5. Use `plt.figure()` function to create a figure instance that you can use to plot your curve, bar chart,… etc on it.

Note: You can read more about `plt.figure()` from this matplotlib.pyplot.figure

Step6. Use the matplotlib library to plot the computed histogram in Step 3.
Step7. Do not forget to use `plt.show()` to view the histogram plot.
Step8. Use `plt.savefig()` function to save the histogram plot in the **output** folder with the name "**<groupNO>_<questionNo>_seagrayscale_hist.jpg**".

Note: you can read more about the `plt.savefig()` from this matplotlib.pyplot.figure

Step9. Compute **the Cumulative distribution function (CDF) of the computed histogram in Step 3**. **CDF(x)** is the number of pixels whose value is less or equal to x, where x is the intensity level. Reference.
Step10. Use `plt.figure()` function to create a figure instance that you can use to plot your curve, bar chart,… etc it.
Step11. Use the matplotlib library to plot the computed CDF in Step 9.
Step12. Use `plt.savefig()` function to save the CDF plot in the **output** folder with the name "**<groupNO>_<questionNo>_seagrayscale_CDF.jpg**".
Step13. Apply histogram Equalization to the image "**seagrayscale.jpg**", and then save the produced image inside the **output** folder with the name "**<groupNO>_<questionNo>_seagrayscale_eq.jpg**".

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Step14. View the produced image from **Step13** on screen using **cv2.imshow**.

Step15. Now, compute the histogram for the image produced by **Step13** "**<groupNO>_<questionNo>_seagrayscale_eq.jpg**". Review the lecture slides for different ways to compute the histogram.

Step16. Use `plt.figure()` function to create figure instance that you can use to plot your curve, bar chart,… etc on it.

Step17. Use matplotlib library to **plot** the computed histogram in **Step15**.

Step18. Use `plt.savefig()` function to save the histogram plot in output folder with name "**<groupNO>_<questionNo>_seagrayscale_eq_hist.jpg**".

Step19. Compute the Cumulative distribution function (CDF) of the computed histogram in **Step 14**. **CDF(x)** is the number of pixels whose value is less or equal to x, where x is the intensity level.

Step20. Use `plt.figure()` function to create a figure instance that you can use to plot your curve, bar chart,… etc on it.

Step21. Use the matplotlib library to **plot** the computed CDF in **Step19**.

Step22. Use the `plt.savefig()` function to save the CDF plot inside the **output** folder with the name "**<groupNO>_<questionNo>_seagrayscale_eq_CDF.jpg**".

Step23. Write a small paragraph explaining the comparison between the image before and after histogram equalization. Briefly discuss the effect of histogram equalization on the CDF.

>>>>>Write your answer here <<<<<

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Answer the following sub-questions:

Sub-Question 1. What is a histogram in the context of image processing? What information does it provide about an image?

>>>>>Write your answer here <<<<<

Sub-Question 2. Describe the method you used to compute the histogram of the grayscale image. What functions or tools were involved?

>>>>>Write your answer here <<<<<

Sub-Question 3. What is the Cumulative Distribution Function (CDF) of an image histogram? What does it tell you about the image?

>>>>>Write your answer here <<<<<

Sub-Question 4. What is histogram equalization, and how does it affect the image? Why is it a useful technique in image processing?

>>>>>Write your answer here <<<<<

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Part Four: Perform Histogram Equalization on The Color Image

Question 2. Write a code in **question2.py** file to do the following tasks:
Note: You can divide your code into several functions.

Step1. Read image "**seacolor.jpg**" from the data folder with option **cv2.IMREAD_COLOR**.
Step2. View the image on screen using **cv2.imshow**.
Step3. Convert the input image to HSV color mode, and then split the image channels. Now, you have H, S and V channels.
Step4. Apply histogram Equalization to the **V channel** only of the input image "**seacolor.jpg**".
Step5. Use the newly equalized V channel from **Step4** to merge the image channels again and create a new image.
Step6. View the produced image from **Step5** on screen using **cv2.imshow**.
Step7. Now, save the produced image from **Step5** inside the **output** folder with the name "**<groupNO>_<questionNo>_seacolor_eq.jpg**".

Step8. Write a small paragraph explaining the comparison between the image before and after histogram equalization. Briefly discuss our approach to applying histogram equalization on color images.

>>>>>Write your answer here <<<<<

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Deliverables and Group Work

Create workshop report with the following name format

group_<number>_ws_<workshop number>_report.pdf

For example, if **group16** created a report for **workshop20,** then the report name should be

group_16_ws_20_report.pdf

The workshop report should include:

(a) Complete this declaration by adding your names:

We, ---------- (mention your names), declare that the attached assignment is our own work in accordance with the Seneca Academic Policy. We have not copied any part of this assignment, manually or electronically, from any other source including web sites, unless specified as references. We have not distributed our work to other students.

(b) Specify what each member has done towards the completion of this work:

	Name	Task(s)
1		
2		
3		
4		

(c) Read the workshop questions carefully, if the workshop questions (or part of question) asked for output or response then you should include the output images under the question (or part of question) and write response to answer some of the workshop questions (or part of question).

(d) Submit two files
   a. **submission.zip**
   b. **group_<number>_ws_<workshop number>_report.pdf**