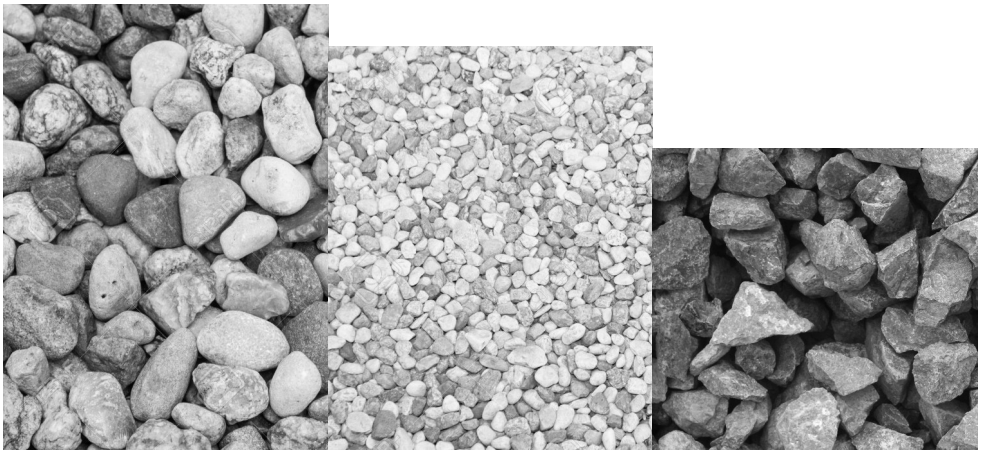
Sabanci University, FENS
CS419 Digital Image and Video Analysis
Fall 2023
Assignment 2

1) You have been given a grayscale digital image (q1...jpg). Your objective is to colorize it with pseudo-colors, in such a way that dark areas appear purple, and bright areas appear bright orange. You are free to select/design any **non-linear functions** (for converting graylevels to color) you desire, as long as they provide the aforementioned appearance **and** they are **derivable** in their definition domain. Provide the graphical plots of the red(p), green(p) and blue(p) functions you use for colorization and their definitions; (p stands for the grayscale pixel value), as well as the colorized image. **(10 points)**.

2) Implement the morphological hole filling technique shown in class, and apply it to the provided image (q2..png). **(10 points)**

3) You'll find attached an aerial image of the city of Pompeii, Italy. It is corrupted with sinusoidal noise due to electrical interference. Examine its Fourier transform and implement an appropriate band reject filter to denoise it (q3..png). **(10 points)**

4) You have somehow graduated and you now work for a computer vision company (GörüBizimİşimiz A.Ş.); your latest client is a cement production company (BetonRıza A.Ş.). The client Mr. Rıza tells you that their company excavates gravel of *only* 3 different types from the same site:



1 2 3

And they need an effective system to tell them apart automagically. In other words, the final software/system is supposed to take an image of the gravel (with a camera) as input, and guess the gravel type as accurately as possible.

Mr. Rıza provides you with 1 sample image (labeled-1.png, labeled-2.png, labeled-3.png) from each gravel type. And also gives you 1 unlabeled sample from each (unlabeled-A.png, unlabeled-B.png, unlabeled-C.png). Your task is to develop a program that, when it is given as input an unlabeled gravel image, it will print on screen its type (type: 1, 2 or 3).

Upon hearing this, you immediately remember granulometries from that silly image processing course, and how they could be useful for distinguishing one image from the other. You can simply calculate the distance between the resulting numerical granulometry

series of an unlabeled image and those of the 3 labeled images, and pick the gravel type closest/most similar to it. But, there are so many questions:

a) The objects of interest are sometimes brighter and sometimes darker with respect to their surrounding. Is using opening going to be sufficient?
b) What shape/range of sizes of structuring elements should you use?
c) Should you use openings/closings or openings/closings by reconstruction?
d) As if that wasn't enough, say you calculate the granulometry of an unlabeled image, how are you supposed to compare the resulting numerical series against the granulometry of a labeled image? Should you rely on the Euclidean distance ? Or their Manhattan distance? Or Chebyshev distance? Or something entirely different?

Design and implement a solution for this problem **based on granulometries** and answer the aforementioned questions (a to d) with thorough qualitative and/or quantitative justifications. **(35 points)**

4) Implement median filtering with the marginal strategy and vector strategy (using lexicographical ordering, bitmix ordering, and norm based ordering).

Perform median filtering using the aforementioned 4 versions, on at least 10 different color 24bit RGB images corrupted with various levels of salt and pepper noise. Report your findings in terms of MSE.

a) Which one filters the image best, and by how much?
b) Does their relative performance depend on the image?
c) Or on the level/correlation of noise?
d) What about the effect of the filter size?
e) What about the effect of the color space?

Answer all questions and discuss your findings. **(35 points)**

Instructions

1. Integrity: Plagiarism is strongly prohibited and may lead to failure of this course.

2. Questions: Contact the TA for any questions you might have.

3. Write-up: Please submit your answers as a zip file containing the documented **python notebook** of your implementations (**as ipynb files**) and a single **pdf file** type-set with LateX containing your answers to the various questions. Do not submit scans or photographs of handwritten documents, or pdfs prepared in word/libreffice, they will not be accepted for evaluation.

4. Collaboration: You can work in groups, however each student must submit their own work.

5. You are free to use the OpenCV libraries only for image loading and displaying. You are expected to implement the rest on your own.

Good luck.