BBM 415 - Image Processing Practicum

HACETTEPE UNIVERSITY
Department of Computer Engineering

Problem Set 2
Fall '2021-2022
TA. Yunus Bilge
Dr. Aydın Kaya

Filtering Colorful Images

Due Date: 23:59:59, 09/12/2021 Thursday

a) Input b) Kuwahara filter result

Figure 1: Input image and possible result of it

Background

Image filtering is one of the most fundamental tasks in Image Processing. It has been used for very different purposes such as image smoothing and edge detection. The main aim of image smoothing is to remove the high frequency component of the given image and to obtain the low frequency component. Basically, smoothing is carried out by convolving an image with a low-pass filter like the Gaussian filter kernel. The goal of edge detection is to determine the pixels where the brightness values are changed abruptly. Sobel and Prewitt filters are some of the examples to edge detection filters.

Many image editing tools like Photoshop let the user to perform some special filters on the images for various artistic effects. For example, one can obtain cartoon like images, pencil drawing images, etc.

Overview

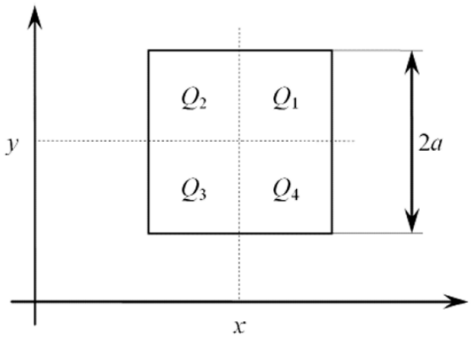
The goal of this assignment is to implement Mean Filter, Gaussian Filter with a specified parameter and Kuwahara filter[1]. A sample image for Kuwahara Filter[1] showing a *possible* result is given above.

Details

Your program will take a color image as input and produce a filtered version of the input image as output by performing Mean Filter, Gaussian Filter and Kuwahara filter on it. The formulation for Kuwahara Filter of each step is given below for grayscale images. You should implement all the filters for color images.

1. **Formulation For Kuwahara Filter**

   Let I is a grayscale image and a square of length 2a centered around a point (x,y) which is partitioned into four identical square subregions Q_1, Q_2, Q_3, Q_4 like in below.



To calculate Kuwahara filter, we have to calculate local average($m_i(x, y)$) and the local standard deviation($s_i(x, y)$) for each subregion $Q_i(x, y)$ where i represents subregion id($i = 1..4$). Kuwahara filter can be calculated by using

$$\Phi(x, y) = \sum_i m_i(x, y) f_i(x, y)$$

where

$$f_i(x, y) = \begin{cases} 1, & s_i(x, y) = \min_k\{s_k(x, y)\} \\ 0, & \text{otherwise.} \end{cases}$$

2. **Details for Implementation**

   For all of the filters, window size parameter will affect the result. You should get results for 3x3, 5x5, 7x7, and 9x9 window sizes. The window size determines the size of square window.

Details for Report

Your report should contain a brief overview of the filters, the details of your approach, and the results of your algorithm on at least 5 different images with your comments. You should contain the items listed below:

- comment about parameters and their effects(generate results with different parameters, add to the report and examine the results).
- explanation of behaviour of the filtering methods.
- comment about difference between filters(advantages and disadvantages compared to each other)
- You have to use LaTeX.

If your algorithm failed to give a satisfactory result on a particular image, provide a brief explanation of the reason(s).

Grading

The assignment will be graded out of 100 : Code + Report:

- 100 points: CODE: 50 (a correct solution) and REPORT: 50

Academic Integrity

All work on assignments must be done individually unless stated otherwise. You are encouraged to discuss with your classmates about the given assignments, but these discussions should be carried out in an abstract way. That is, discussions related to a particular solution to a specific problem (either in actual code or in the pseudocode) will not be tolerated. In short, turning in someone else's work, in whole or in part, as your own will be considered as a violation of academic integrity. Please note that the former condition also holds for the material found on the web as everything on the web has been written by someone else.

References

[1] M. Kuwahara, K. Hachimura, S. Eiho, and M. Kinoshita. Processing of ri-angiocardiographic images. In Jr. Preston, K. and M. Onoe, editors, *Digital Processing of Biomedical Images*, pages 187–202. Springer US, 1976.