BIL 415 - Image Processing Practicum

HACETTEPE UNIVERSITY
Department of Computer Engineering

Problem Set 3
Fall 2016
Dr. Erkut Erdem
TAs. Levent Karacan
TAs. Efsun Sezer

Image Filtering for Stylization

Due Date: 23:59pm on Friday, December 9th, 2016

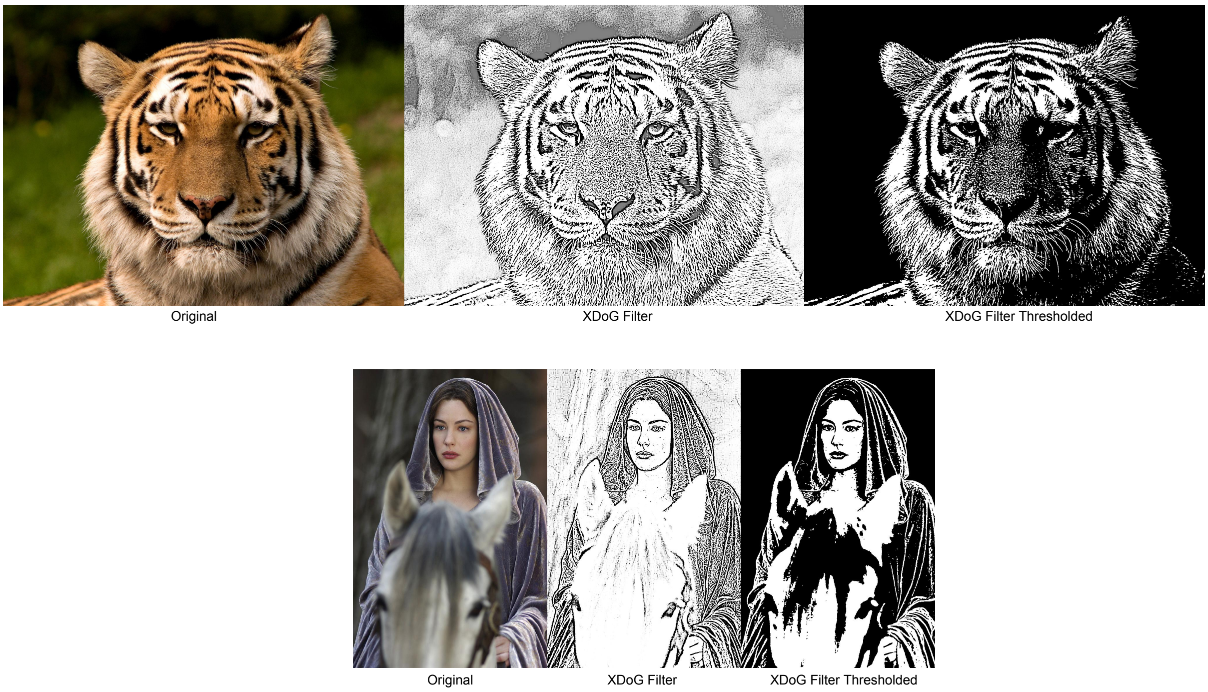

Figure 1: Input images and filtered images by XDoG filter

Background

Image filtering has been used for very different purposes such as image smoothing and edge detection. In an effort to decompose and analyze images, edges play an important role in both human and computer vision [1]. The goal of edge detection is to determine the pixels where the brightness values are changed abruptly. Canny,Sobel,Prewitt,LoG,DoG filters are some of the examples to edge detection operators. Many image editing tools like Photoshop let the user to perform some special filters on the images for various artistic effects such as drawings or sketches using edge detector as part of filtering process. DoG(Difference of Gaussians) edge detection operator is commonly used for such artistic effects. Difference of Gaussians is the subtraction of one blurred version of an original image from less blurred version of the original image. An extension of DoG operator(XDoG) is described by H. Winnemoller[2] to use DoG operator for giving various types of effects to an input image.You may refer to the article for the details and to understand how those processes are performed.

Overview

In this assignment, you will implement XDoG filtering operator to give various types of effect to the input images like in Figure1 by playing with parameters defined in equations as follows:

$$g(\hat{x}, \sigma) = \frac{1}{2\pi\sigma^2} e^{-\frac{||\hat{x}||^2}{2\sigma^2}} \tag{1}$$

$$G(\hat{x}, \sigma, I) = \frac{1}{2\pi\sigma^2} \int I(x) e^{-\frac{||\hat{x}-x||^2}{2\sigma^2}} dx \tag{2}$$

$$D_0(\hat{x}, \sigma, k, I) = G(\hat{x}, \sigma, I) - G(\hat{x}, \sigma.k, I) \tag{3}$$

$$E(\hat{x}, \sigma, k, I) = \begin{cases} 1 & \text{if } D_0(\hat{x}, \sigma, k, I) > 0 \\ 0 & \text{otherwise} \end{cases}$$

$$D_0(\hat{x}, \sigma, k, I) = G(\hat{x}, \sigma, I) - \Gamma.G(\hat{x}, \sigma.k, I) \tag{4}$$

$$E(X(\sigma, k, \Gamma, \epsilon, \Phi) = \begin{cases} 1 & \text{if } D_0(\sigma, k, \Gamma, I) < \epsilon \\ 1 + \tanh(\Phi.(D_X(\sigma, k, \Gamma, I))) & \text{otherwise} \end{cases}$$

Equation 1: Gaussian kernel
Equation 2: Filtering definition
Equation 3: Standart difference of Gaussians with parameters σ and k
Equation 4: Extended difference of Gaussians with parameters $\sigma, k, \Gamma, \epsilon$ and Φ

I: input image
$\hat{x}$: a two-valued coordinate
$||\hat{x} - x||$: kernel neighborhood
σ: standard deviation of Gaussian filter
k: stardard deviation rate between two Gaussian filters
Γ: XDoG parameter specify edge and noisy balance
Φ: XDoG parameter controlling the steepness of the edge transition.
ϵ: Threshold value specify edge sensitivity

Details

Your Matlab program will give similar effect like in Figure 1. For this purpose, you will implement a XDoG operator(Equation 4) and play its parameters to give satisfactory effects. Especially you should play ϵ,σ, Φ and Γ parameters. You can assign as $k = 1.6$

- You must take results on the least 5 images you will take.
- You must play with parameters specified above.
- You must show your results in your report.
- You must also comment your results why they are satisfactory or not.
- You must play with related parameters and explain how they work and affect the results. Analyzing the results with appropriate comments you will do is important for your assignments.

Grading

- The assignment will be graded out of 100 : Code + Report
- The following features will be taken into account while grading:
  - Completeness - does your program implement the whole assignment?
  - Correctness - does your program provide the right output?
  - Programming style (including documentation and program organization) - is the program well designed and easy to understand?
  - Your LATEX report should contain a brief overview of the problem, the details of your approach, and the results of your algorithm on at least 5 images with your comments. Show the results of all of the main steps. If your algorithm failed to give a satisfactory result on a particular image, provide a brief explanation of the reason(s).

What to Hand In

You are required to submit all your code along with a short report in *LATEX*. For that purpose, prepare a folder containing

- `README.txt` *(text file containing details about your code)*
- `code/` *(directory containing all your code)*
- `report.pdf/` *(a report which is prepared with LATEX)*

Archive this folder as `pset3.zip` and submit via https://submit.cs.hacettepe.edu.tr .

Policy

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 pseudo code) will not be tolerated. In short, turning in someone elses work(from internet), 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] David Marr and Ellen Hildreth. Theory of edge detection. *Proceedings of the Royal Society of London. Series B. Biological Sciences*, 207(1167):187–217, 1980.

[2] Holger Winnemöller. Xdog: advanced image stylization with extended difference-of-gaussians. In *Proceedings of the ACM SIGGRAPH/Eurographics Symposium on Non-Photorealistic Animation and Rendering*, pages 147–156. ACM, 2011.