BIL 415 - Image Processing Practicum

HACETTEPE UNIVERSITY
Department of Computer Engineering

Problem Set 2
Fall '2013-2014
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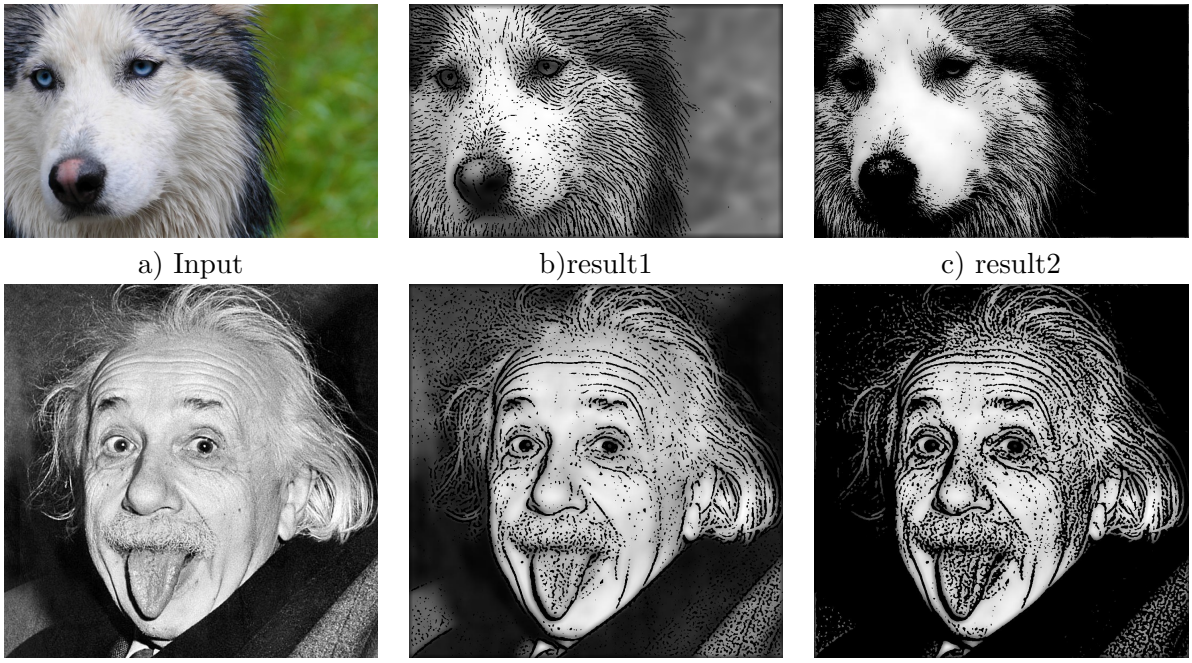
Extended Difference of Gaussians for Image Stylization

Due Date: 23:59pm on Monday, November 25th, 2013



a) Input b)result1 c) result2

d) Input e)result1 f)result2

Figure 1: Input images and filtered images by XDoG filter with different parameters

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. 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 operator to give images various effect like in Figure1 by playing with parameters defined in equations as follows:

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

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

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

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

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

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

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
$\hat{x}$: co-ordinate pixels
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 and Γ parameters. You can assign as $k = 1.6$ and $\Phi = 1$;

- 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.

What to Hand In

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

- `README.txt` *(text file containing details about your project)*
- `code/` *(directory containing all your code)*
- `HTML/` *(directory containing all your documents, including your images)*
- `HTML/data/` *(including your data images)*
- `HTML/result/` *(including your result images)*
- `HTML/index.html` *(html report)*

Archive this folder as `pset2.zip` and send to `karacan@cs.hacettepe.edu.tr`.

In this assignment you will write detailed report which contains a brief overview of the problem, details of your implementation and the results with your comments. You must play with related parameters. .All results you obtain must be put to your report and all observations must be specified clearly. Analyzing the results with appropriate comments you will do is important for your assignments.

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

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.