Homomorphic Filtering

Advance Image Analysis

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Contents

Introduction

Homomorphic filters are a generalized image processing technique which are used for image enhancement and noise removal. It can be described a non-linear mapping from on one specific domain to another, where it will allow for a linear filter techniques to be applied.

Image Enhancement

What Is Image Enhancement ?

The principal objective of image enhancement is to modify attributes of an image to make it more suitable for a given task. For example, removing some type of noise or sharpen an image, Increase brightness.

Ex: Histogram Equalization, Median Filters,..

Image Enhancement

Methodology (Overview)

Homomorphic Filtering is used to remove a type of noise called Multiplicative noise.

$$S(x, y) = R(x, y)L(x, y)$$

Methodology (Illumination And Reflectance Model)

A 2d image can be described as a combination of its illumination and reflectance functions.

$$S(x, y) = R(x, y)L(x, y)$$

Remove the illumination factor, L(x,y), in the image model while keeping the reflectance factor, R(x,y).

Methodology (Homomorphic Filters Algorithm)

1. convert the model components multiplication into summation which is done using the log function.

$$ln(S(x,y)) = ln(R(x,y)L(x,y))$$

$$ln(S(x,y)) = ln(R(x,y)) + ln(L(x,y))$$

Cont...

2. Convert the image model to the frequency domain.

$$F[ln(S(x,y))] = F[ln(R(x,y))] + F[ln(L(x,y))]$$

$$Z(u,v) = F_R(u,v) + F_I(u,v)$$

Cont...

3. Apply one of the High pass filters like Gaussian or Butterworth filters.

$$O(u,v) = H(u,v).Z(u,v) = H(u,v).F_R(u,v) + H(u,v).F_I(u,v)$$

Cont...

4. Take the inverse of the Fourier Transform.

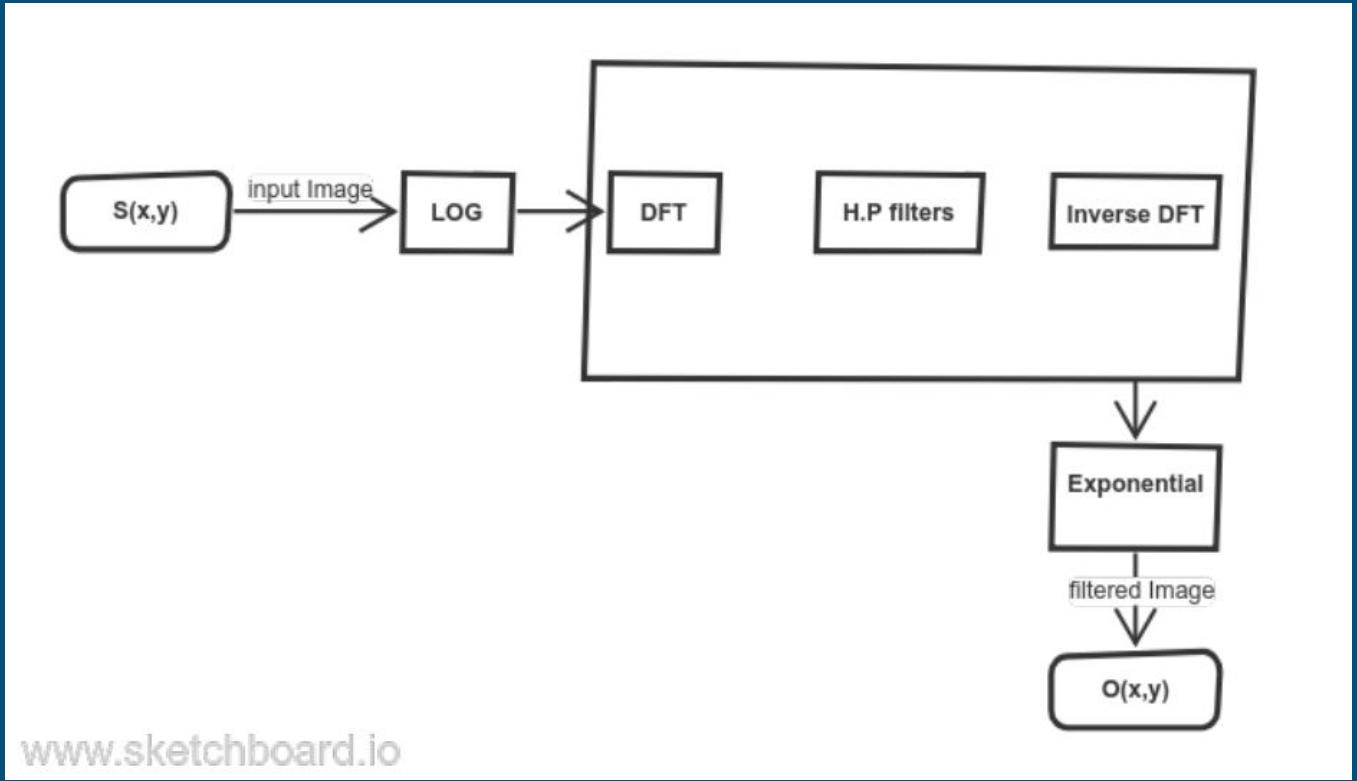
$$O(x,y) = F^{-1}[O(u,v)] = F^{-1}[H(u,v).F_R(u,v) + H(u,v).F_I(u,v)]$$

cont...

5. Take the inverse of the Fourier Transform.

$$O(x, y) = exp[O(x, y)]$$

Cont..


S(x,y)
input Image
LOG
DFT
H.P filters
Inverse DFT
Exponential
filtered Image
O(x,y)
www.sketchboard.io

High Pass Filters

We apply high pass filters on the log transformed image, to provide to remove the low frequencies in the image as been described before. The filter we used in the implementation Gaussian H.P Filter.

$$H(u,v) = 1 - exp^{\frac{(u-\frac{M}{2})^2+(v-\frac{N}{2})^2}{2\times\sigma^2}}$$

Implementation

Github page for the code

Original Image

Homomorphic Filtered Image

Conclusion

1. Image enhancement is an important concept in image processing which will enable us to make an improvement on the image quality.
2. Dealing with non-uniform illumination and trying to remove the noise by adjusting the contrast images and contrast can be considered a crucial factor before the segmentation or any related task process.
3. Generally, image enhancement can be done in the spatial domain and frequency domain. In this Homomorphic filtering approach the process is done in the frequency domain.
4. The filter can make other illumination artefacts on the edges of the foreground.