Wiener Filter

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***Abstract*—The goal of the Wiener filter is to compute a statistical estimate of an unknown signal using a related signal as an input and filtering that known signal to produce the estimate as an output. For example, the known signal might consist of an unknown signal of interest that has been corrupted by additive noise. The Wiener filter can be used to filter out the noise from the corrupted signal to provide an estimate of the underlying signal of interest. The Wiener filter is based on a statistical approach, and a more statistical account of the theory is given in the minimum mean square error (MMSE) estimator article.**

I. Introduction

Typical deterministic filters are designed for a desired frequency response. However, the design of the Wiener filter takes a different approach. One is assumed to have knowledge of the spectral properties of the original signal and the noise, and one seeks the linear time-invariant filter whose output would come as close to the original signal as possible. Wiener filters are characterized by the following: Assumption: signal and (additive) noise are stationary linear stochastic processes with known spectral characteristics or known autocorrelation and cross-correlation Requirement: the filter must be physically realizable/causal (this requirement can be dropped, resulting in a non-causal solution) Performance criterion: minimum mean-square error (MMSE) This filter is frequently used in the process of deconvolution .

II. Aims

1) Loading an image .
2) Blurring the previous image.
3) Applying Fourier Transform.
4) Adding noise to the image.
5) Applying Inverse Fourier transform.
6) Know more about Weiner Filter.
7) Comparison between Weiner and Homomorphic filter.

III. Problem Definition

The main idea is about filtering the noised blurred images using Wiener filter :

$$y(t) = h(t) * x(t) + N(t) \tag{1}$$

while :

- y(t) is the noised blurred image.
- h(t) Gaussian filter to blure the image.
- x(t) the normal image.
- N(t) the noise.

So to apply Weiner filter we should follow the next steps :

- Blurring the Image
- Applying Fourier Transform.
- Adding noise.
- Applying inverse Fourier Transform.

IV. Weiner Filter

A. Loading an image

We will apply the filter on the next image :

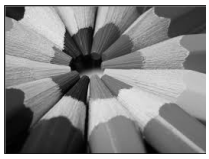

Fig. 1. the orginal image

B. Blurring the image

Lowpass filters can blur the image ,here we are using the Gaussian filter to blur the image :

Fig. 2. the blurred image

C. Apllying Fourier

Fourier transform can move the image from the time domain to frequency domain ,which convert the convolution operation to multiplication operation :

$$y(t) = h(t).x(t) \tag{2}$$

D. Adding noise

there are many types of noise:like salt and pepper ,periodic... in this research I have used salt and pepper noise to effect on the image and make the Weiner filter mission be more difficult (actually In the real life images have a natural noise and our mission is to reduce this noise using filters) :

$$y(t) = h(t).x(t) + N(t) \tag{3}$$

Fig. 3. the noised image

E. Inverse Foureir Transform

After we had a noised blurred image ,by applying the inverse transform we can filter the noise to get an image like the original one but have some details missed :
we notice that the filter has removed the noise and the blur

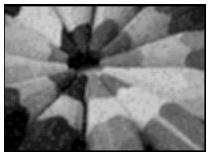

Fig. 4. the final image

became less ,So this filter is used very much with real life applications.

V. Comparing with Histogram Equaliztion and Homomorphic filters

A. Histogram equalization

Histogram equalization depends on rearranging the pixels in the image to get better view ,By apllying Histogram equalization on the image : we notice that histogram equalization

Fig. 5. Histogram equalization

cannot effect on salt and pepper noise but it reduce blurring very much,while Weiner filter can remove the noise.

B. Homomorphic filter

By applying the homomorphic filter on the previous image we get : we notice that the image became more blurred and the

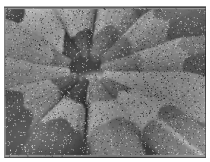

Fig. 6. Homomorphic filter

noise has not been removed ,while Weiner remove the noise .

VI. Application

The Wiener filter has a variety of applications in signal processing, image processing, control systems, and digital communications. These applications generally fall into one of four main categories:

1) System identification.
2) Deconvolution.
3) Noise reduction.
4) Signal detection.

VII. conclusion

In our researches we can face a real problem with the uncleared images,so we need to filter these images from the noise and other effects.This make weiner filter a very effective method in image processing feild because this filter has a big effective on noised blurred image to conclude a clear image which helps very much .I hope that this report a real advantage a bout Weiner filter and How it works .