Image Processing

Image Restoration (Part I)

Pattern Recognition and Image Processing Laboratory (Since 2012)

Introduction

Restoration attempts to reconstruct or recover an image that has been degraded by using a priori knowledge of the degradation phenomenon.

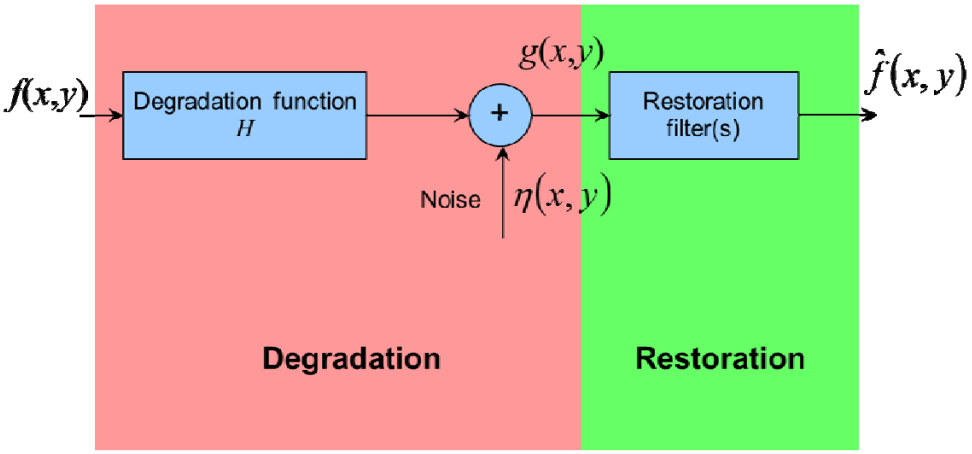
Introduction

… Thus, restoration techniques are oriented toward modeling the degradation and applying the inverse process in order to recover the original image.

Introduction

Degradation Image

A Model of the Image Degradation/ Restoration Process



The more we know about H and $\eta(x,y)$, the closer $\hat{f}(x,y)$ will be to $f(x,y)$.

A Model of the Image Degradation/ Restoration Process

In the spatial domain, the degraded image is given by

$$g(x,y) = h(x,y) * f(x,y) + \eta(x,y)$$

Frequency domain

$$G(u,v) = H(u,v)F(u,v) + N(u,v)$$

Noise Models

Two types of noise models:

- **Noise in spatial domain**
- **Noise in frequency domain**

Noise Models

Adding noise with function imnoise

```
>> g = imnoise(f, type, parameters)
>> ex5_01   % See demonstration
```

Noise Models

Generating spatial random noise with a specified distribution

```
>> ex5_01   % See demonstration
```

Noise Models

Periodic Noise

Periodic noise in an image arises typically from electrical and/or electromechanical interference during image acquisition.

```
>> ex5_01   % See demonstration
```

Restoration in the Presence of Noise Only–Spatial Filtering

Spatial noise filters

```
>> ex_snf   % See demonstration
```

Restoration in the Presence of Noise Only–Spatial Filtering

Spatial noise filters

Arithmetic mean: $A(a_1, a_2, \ldots, a_n) = \frac{1}{n}\sum_{i=1}^{n} a_i$

Geometric mean: $G(a_1, a_2, \ldots, a_n) = \left(\prod_{i=1}^{n} a_i\right)^{1/n} = \sqrt[n]{a_1 a_2 \cdots a_n}$

Contraharmonic mean: $C(x_1, x_2, \ldots, x_n) = \frac{\left(\frac{x_1^2 - x_2^2 + \cdots + x_n^2}{n}\right)}{\left(\frac{x_1 - x_2 + \cdots + x_n}{n}\right)},$

PSF: Point Spread Function, a degradation function in a spatial domain.

Restoration in the Presence of Noise Only–Spatial Filtering

Adaptive spatial filters

```
Zmin = minimum intensity value in Sxy
Zmax = maximum intensity value in Sxy
Zmed = median of the intensity value in Sxy
Zxy = intensity value at coordinates (x, y)
Level A: If Zmin < Zmed < Zmax, go to level B
              Else increase the window size
         If window size <= Smax, repeat level A
              Else output Zmed
Level B: If Zmin < Zxy < Zmax, output Zxy
              Else output Zmed
```

Restoration in the Presence of Noise Only–Spatial Filtering

Adaptive spatial filters

```
>> ex_asf   % See demonstration
```

Periodic Noise Reduction by Frequency Domain Filtering

```
>> ex5_02   % See demonstration
```