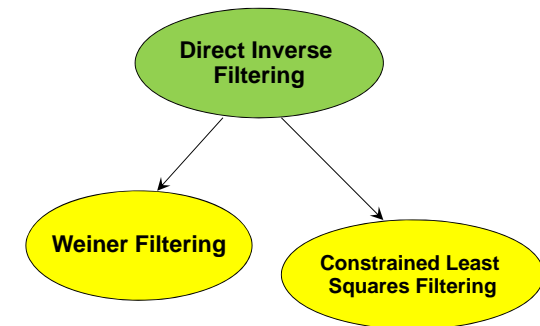# Image Processing

Image Restoration (Part II)

Pattern Recognition and Image Processing Laboratory (Since 2012)

Approaches for Image Restoration

Direct Inverse Filtering

Weiner Filtering

Constrained Least Squares Filtering

Note: - These approaches are **linear image restoration.**
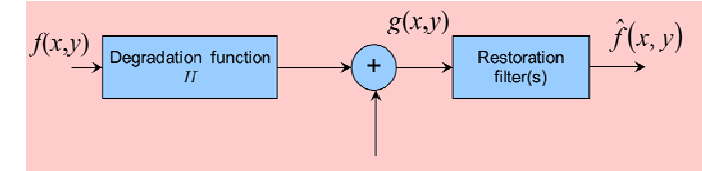- PSF (Point Spread Function) is available.

Approaches for Image Restoration

Lucy-Richardson Algorithm

Blind Deconvolution

Note: - These approaches are **nonlinear image restoration.**
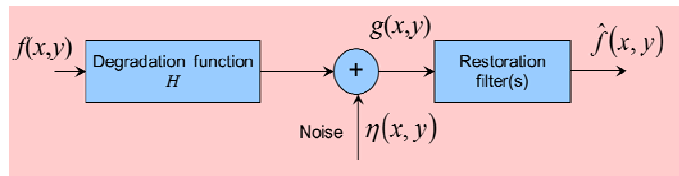- PSF is **NOT** available.

Direct Invert Filtering

$f(x,y)$ → Degradation function H → + → $g(x,y)$ → Restoration filter(s) → $\hat{f}(x,y)$

Degradation Eq

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

$$\hat{F}(u,v) = \frac{G(u,v)}{H(u,v)}$$

Restoration Eq

Direct Invert Filtering

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

Degradation Eq

$$\hat{F}(u,v) = F(u,v) + \frac{N(u,v)}{H(u,v)}$$

Restoration Eq

Wiener Filtering

'0'

$$\hat{F}(u,v) = \left[\frac{1}{H(u,v)} \frac{|H(u,v)|^2}{|H(u,v)|^2 + S_\eta(u,v)/S_f(u,v)} \right] G(u,v)$$

$$\hat{F}(u,v) = \frac{G(u,v)}{H(u,v)}$$

Direct Inverse Filtering

Wiener Filtering

```
>> fr = deconwnr(g, PSF) % Direct Inverse Filter
>> fr = deconwnr(g, PSF, NSPR) % Parametric Weiner Filter
>> fr = deconwnr(g, PSF, NACORR, FACORR) % Weiner Filter with
                                    % Autocorrelation

>> degrad5_5 % See demonstration
```

Constrained Least Squares Filtering

'0'

$$\hat{F}(u,v) = \left[\frac{H^*(u,v)}{|H(u,v)|^2 + \gamma |P(u,v)|^2} \right] G(u,v)$$

$$\hat{F}(u,v) = \frac{G(u,v)}{H(u,v)}$$

Direct Inverse F iltering

**Iterative Nonlinear Restoration
Using the Lucy-Richardson Algorithm**

>> degrad5_9 % See demonstration

Blind Deconvolution

One of the most difficult problems in image restoration is obtaining a suitable estimation of the PSF to use in restoration algorithm.

Blind Deconvolution

Image restoration methods that are NOT based on specific knowledge of the PSF are called "blind deconvolution" algorithm.

Blind Deconvolution

>> degrad5_10 % See demonstration

The end of
part II