Noise reduction

Noise in an image is a random variation in brightness or color information in a captured image. Image signal deterioration due to external factors. Images with multiplicative noise have the property that brighter areas are noisier. But most of them are additives. Noise is always present in digital images during the steps of image acquisition, encoding, transmission and processing. It is very difficult to remove noise from digital images without prior knowledge of filtering techniques.
A noisy image can be modeled as follows:-

$A(x,y) = H(x,y) + B(x,y)$ Where, A(x,y)= function of noisy image, H(x,y)= function of image noise , B(x,y)= function of original image.

Why is noise removal important in image processing?

Removing noise from an image is a major task in the field of image processing as it degrades the image quality and some important information is lost due to noise effects. Denoise images using various image filtering techniques.

Noisy Image

Denoised Image

Some of important Image Noise are followed:-

- Gaussian noise :- Gaussian noise occurs in images due to factors such as electronic circuit noise and sensor noise due to poor lighting and high temperatures.
- Salt-and-pepper noise :- Found in situations where quick transients, such as faulty switching, take place during imaging.
- Periodic noise :-Usually caused by electrical or electromechanical interference during image acquisition

◘ For denoising the Image we need to apply some filters on Image

some of most used filters are followed :-

- **Arithmetic mean filter** :- The arithmetic mean computes average value of the corrupted image *f^* at point *(x,y)* is the arithmetic mean computed using the pixels in the region defined by S_{xy}.
- **Geometric mean filter** :- A geometric mean filter is an image filtering process designed to smooth and reduce noise in an image. It is based on mathematical geometric mean. The geometric mean output image G(x,y) is given by . where S(x,y) is the original image and the filter mask is m-by-n pixels.
- **Harmonic Mean filter** :- In the harmonic mean method, the color value of each pixel is replaced with the harmonic mean of color values of the pixels in a surrounding region.
- **Contra Harmonic Mean filter** :- This filter reduces or virtually eliminates the effects of salt and pepper noise. For positive Q values, the filter removes pepper noise. Negative Q values remove salt noise.

Filters for removing Periodic Noise:-

1. **Band Reject filter**:- A band-reject filter is useful when the typical location of noise in the frequency domain is known.The band notch filter blocks frequencies within a selected range and passes frequencies outside the range.

2. **Bandpass filter** :- A bandpass attenuates very low and very high frequencies while preserving the midrange frequency band. Bandpass filtering can be used to reduce noise (cut high frequencies) while enhancing edges (reducing low frequencies).

3. **Notch filter** :- A notch filter (NF) is a bandstop filter that greatly attenuates certain frequency signals but passes all other frequency components with negligible attenuation.

WIENER FILTERING

- An approach that includes both degradation features and noise statistics in the reconstruction process.
- The Wiener filter is an MSE optimal fixed linear filter for images degraded by additive noise and blur. Computing a Wiener filter requires the assumption that the signal and noise processes are second-order stationary (in the sense of a random process).