Unit-2 |16/11/23 Probability density function (PDF)...

① PDF for noise model [Idol Pg. 63]

② DFT IDFT [Idol pg. 51]

③ Frequency Domain filtering [Idol pg. 53]

④ Image Smoothing and sharpning [Idol pg. 54]

⑤ Image Degradation/Restoration process [Idol pg. 62]

Q. Periodic Noise Reduction Using Frequency Domain Filtering

➢ ***The following techniques can be used to reduce the noise effect***

1. Mean Filters

1. Arithmetic Mean Filters

- Computes average value of corrupted image in area S xy.
- Uses convolution mask with coefficients 1/mn.
- Smoothes local variations, reducing noise through blurring.

2. Geometric Mean Filters

- Restored image given by product of pixels in subimage area, raised to power 1/mn.
- Achieves smoothing like arithmetic mean but retains more image detail.

3. Harmonic Mean Filter

- Effective for salt noise, less so for pepper noise or Gaussian noise.
- Operation involves harmonic mean.

4. Contraharmonic Mean Filter

- Yields restored image based on expression involving Q (order of filter).
- Suited for reducing effects of salt-and-pepper noise, with Q determining noise type elimination.
- Reduces to arithmetic mean filter at Q=0, to harmonic mean filter at Q=-1.

2 . Order Statistics Filters

1. Median Filters

- Replace pixel value with the median of intensity levels in a defined neighborhood.
- Excellent noise reduction without significant blurring.
- Particularly effective against impulse noise.
- $$\hat{f}(x,y) = \underset{(r,c)\in S_{xy}}{\text{median}}\{g(r,c)\}$$

2. Max and Min Filters

- Max filter: Uses the 100th percentile, helpful for finding the brightest points.
- $$\hat{f}(x,y) = \max_{(r,c)\in S_{xy}}\{g(r,c)\}$$
- Min filter: Uses the 0th percentile, useful for isolating the darkest points and reducing salt
- $$\hat{f}(x,y) = \min_{(s,t)\in Sxy}\{g(s,t)\}$$

3. **Mid-point Filter**

- Computes the midpoint between max and min values in the filter area.
- Combines order statistics and averaging, effective for randomly distributed noise.
- $\hat{f}(x,y) = \left(\max_{(s,t)\in S_{xy}} \{g(s,t)\} + \min_{(s,t)\in S_{xy}} \{g(s,t)\} \right) / 2$

4. **Alpha-Trimmed Mean Filter**

- Averages remaining pixels after excluding a certain percentage (d) of extreme values.
- Can vary from arithmetic mean to median based on the chosen parameters.

$$\hat{f}(x,y) = \frac{1}{mn - d} \sum_{(r,c)\in S_{xy}} g_R(r,c)$$