Objectives

In this course you will learn the following:

- Image Processing
- Spatial Domain processing example
- Frequency domain approach
- Magnitude of $F(u)$
- 2-D Discrete Fourier Transform
- Spatial Domain

Image Processing

Spatial domain processing:

$$g(x,y) = h[f(x,y)]$$

Where,

- $g$ - output image
- $h$ - depends on properties of $p$ and neighboring pixels
- $f$ - input Frequency domain processing

$$\sum_{j=-1}^{1} \sum_{k=-1}^{1} W_{jk}f(x+j,y+k) = W_{-1-1}f(x-1,y-1) + W_{-10}f(x-1,y) + W_{-11}f(x-1,y+1) + \ldots$$

$$= W_{00}f(x,y) + W_{01}f(x+1,y) + W_{10}f(x,y+1) + W_{11}f(x+1,y+1) + W_{-11}f(x-1,y+1) + W_{0-1}f(x,y+1) + W_{-10}f(x-1,y) + W_{00}f(x,y)$$
Special Case: 1x1 template

S = T(r) Image, Intensity, Transformation (mapping)

**Magnitude of F(u)**

\[ |F(0)| = 3.25 \]
\[ |F(1)| = \sqrt{\frac{(-2)^2 + 1^2}{16}} = \frac{\sqrt{5}}{4} \]
\[ |F(3)| = \frac{1}{4} \]
\[ |F(4)| = \frac{\sqrt{5}}{4} \]

**2-D Discrete Fourier Transform**

\[ F(u, v) = \frac{1}{N} \sum_{x=0}^{N-1} \sum_{y=0}^{N-1} f(x, y) e^{-2\pi j (ux + vy) / N} \]
\[ f(x, y) = \frac{1}{N} \sum_{u=0}^{N-1} \sum_{v=0}^{N-1} F(u, v) e^{2\pi j (ux + vy) / N} \]
Spatial Domain

- Smoothing – reduce the effect of random noise
  - Neighborhood averaging. Boundaries are softer, fuzzier.
  - Median averaging
    
    NA $\rightarrow$ 103/9 = 11
    MA $\rightarrow$ 2 9 10 10 11 11 12 13 25
    
    | 1/9 | 1/9 | 1/9 | 10 12 11 |
    | 1/9 | 1/9 | 1/9 | 9  13 25 |
    | 1/9 | 1/9 | 1/9 | 2  10 11 |

- Image averaging: Intensity averaging across many images of the same scene
  - Better reduction of noise
  - Requires good registration of images
    
    | 0 0 1 |
    | 0 1  |
  - Time consuming

- Binary Image smoothing

  - Binary – Boolean expressions. Logic expressions
    
    $B1 = p+b.g.(d+e) + d.e.(b+g)$ - fill one pixel whole
    $B2 = p.((a+b+d).(e+g+h) + (b+c+e).(d+f+g))$ - fill notch
    $B3 = p + (d.f.g).(a+b+c+e+h)$ - fill missing corner

Recap
In this course you have learnt the following

- Image Processing
- Spatial Domain processing example
- Frequency domain approach
- Magnitude of $F(u)$
- 2-D Discrete Fourier Transform
- Spatial Domain

Congratulations, you have finished Lecture 28. To view the next lecture select it from the left hand side menu of the page.