Image Processing

Frequency Domain Processing (Part I)

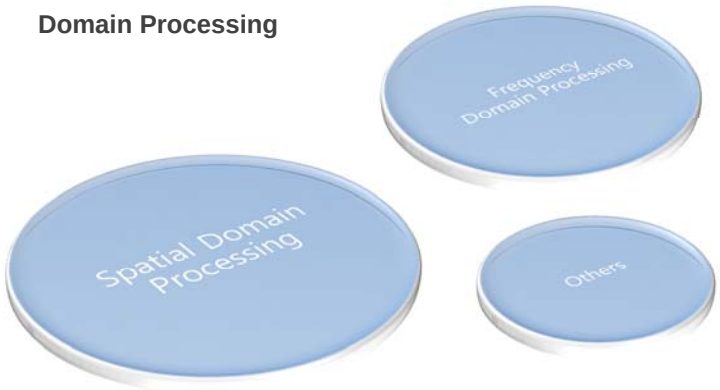
Pattern Recognition and Image Processing Laboratory (Since 2012)

Introduction

Transformation

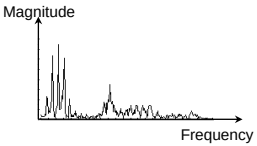
Introduction

Domain Processing

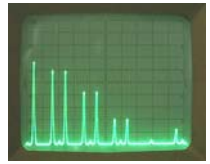


Introduction

What is a Transform?



Time Domain → Transform → Frequency Domain



Introduction

Types of Transforms

- Fourier Transform
- Hanamard Transform
- KLT Transform
- Discrete Cosine Transform
- Wavelet Transform
- ...

2D Discrete Fourier Transform

A frequency domain processing is denoted by the expression.

$$F(u,v) = T[f(x,y)]$$

Frequency Domain

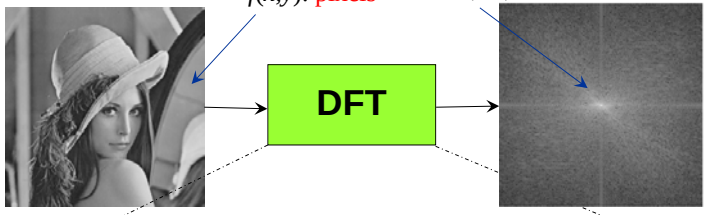
Transformation

Spatial Domain

2D Discrete Fourier Transform

$f(x,y)$: pixels

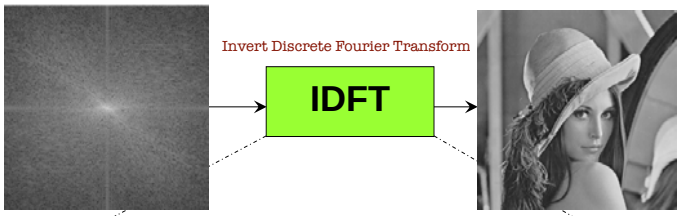
$F(u,v)$: DFT coefficients



$$F(u,v) = \sum_{x=0}^{M-1}\sum_{y=0}^{N-1} f(x,y) e^{-j2\pi\left(\frac{ux}{M}+\frac{vy}{N}\right)};$$

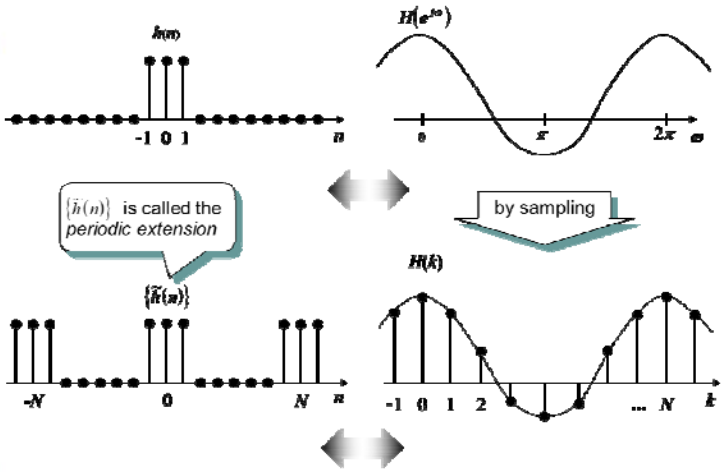
for $u = 0, 1, 2, \ldots, M\text{-}1$ and $v = 0, 1, 2, \ldots, N\text{-}1$.

2D Discrete Fourier Transform



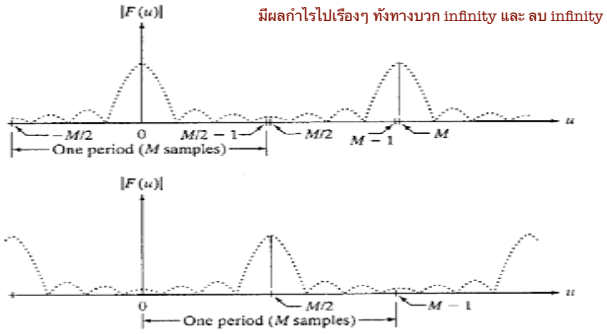
$$f(x,y) = \frac{1}{MN}\sum_{u=0}^{M-1}\sum_{v=0}^{N-1} F(u,v) e^{j2\pi\left(\frac{ux}{M}+\frac{vy}{N}\right)};$$

for $x = 0, 1, 2, \ldots, M\text{-}1$ and $y = 0, 1, 2, \ldots, N\text{-}1$.



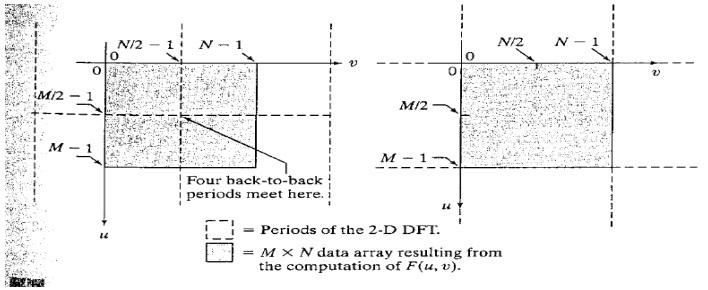
2D Discrete Fourier Transform

Periodicity property of DFT: 1-D case



2D Discrete Fourier Transform

Periodicity property of DFT: 2-D case



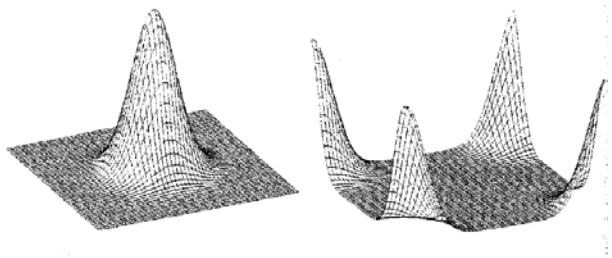
2D Discrete Fourier Transform

Computing and Visualizing the 2-D DFT in MATLAB

>> ex4_01 % See demonstration

2D Discrete Fourier Transform

Computing and Visualizing the 2-D DFT in MATLAB



Filtering in the Frequency Domain

Fundamental Concepts

$$f(x,y) * h(x,y) \Leftrightarrow F(u,v)H(u,v)$$

การประมวลผลบางอย่าง ถ้าอยู่บน Frequency Domain คอมพิวเตอร์จะประมวลผลได้เร็วกว่า

$$f(x,y)h(x,y) \Leftrightarrow F(u,v) * H(u,v)$$

Filtering in the Frequency Domain

>> ex4_02 % See demonstration