

Image Processing

Frequency Domain Processing (Part I)

Pattern Recognition and Image Processing Laboratory (Since 2012)

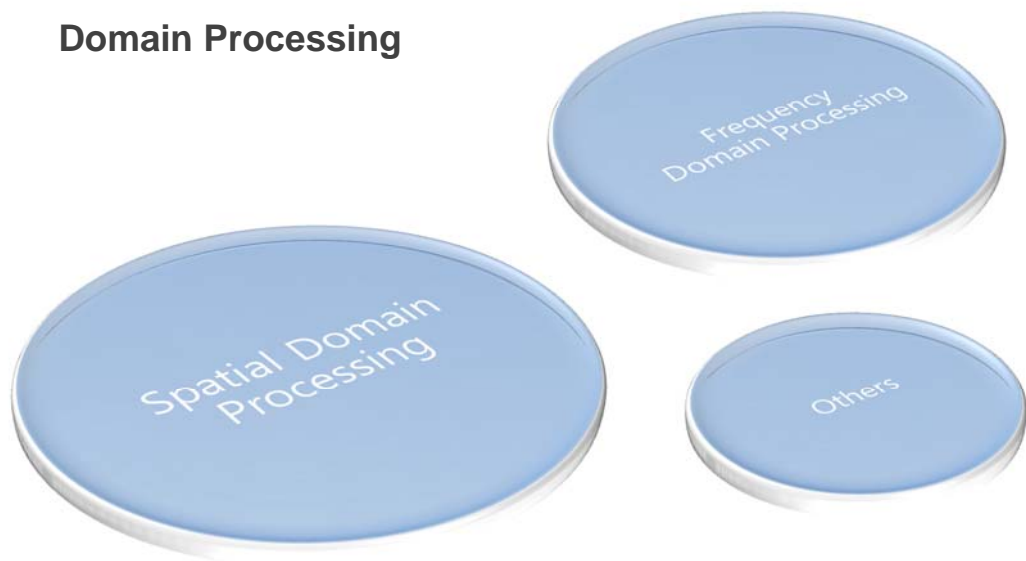
Introduction

Transformation



Introduction

Domain Processing

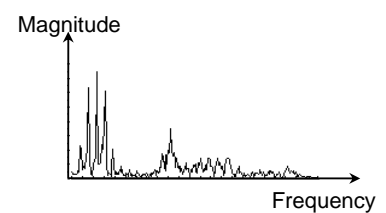
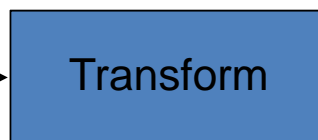


Introduction

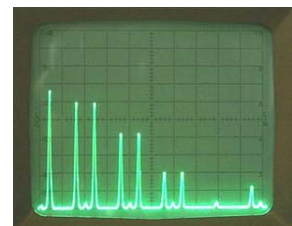
What is a Transform?



Time Domain



Frequency Domain



Introduction

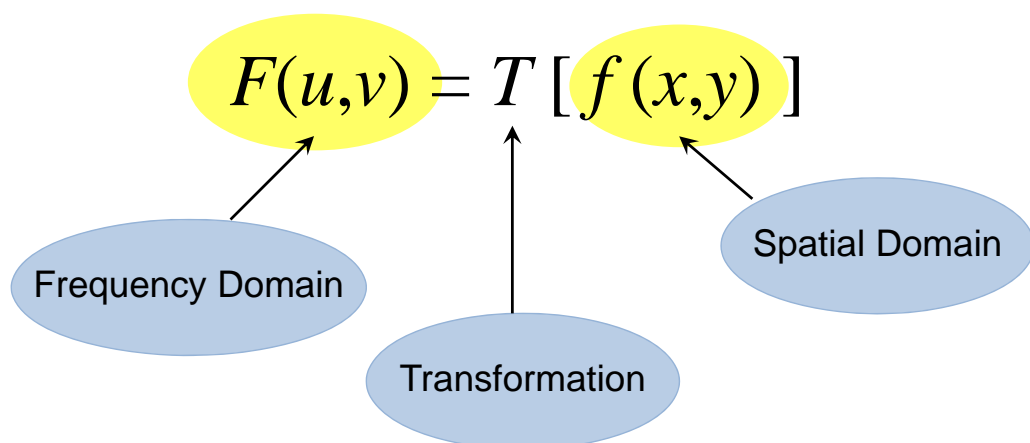
Types of Transforms

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

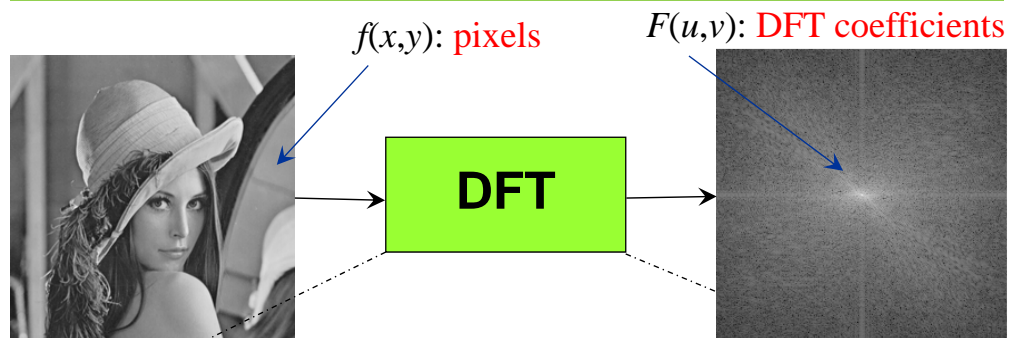


2D Discrete Fourier Transform

A frequency domain processing is denoted by the expression.



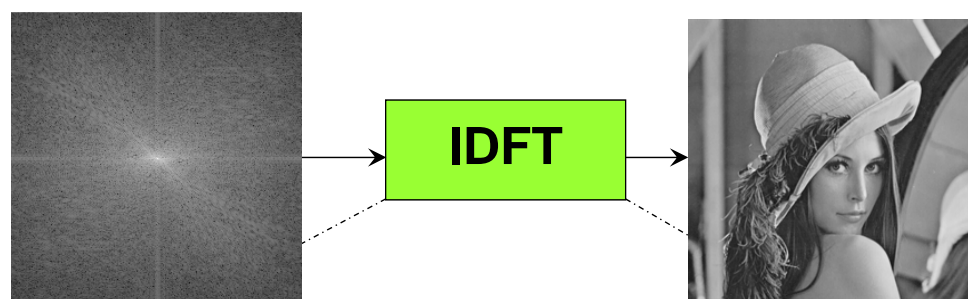
2D Discrete Fourier Transform



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

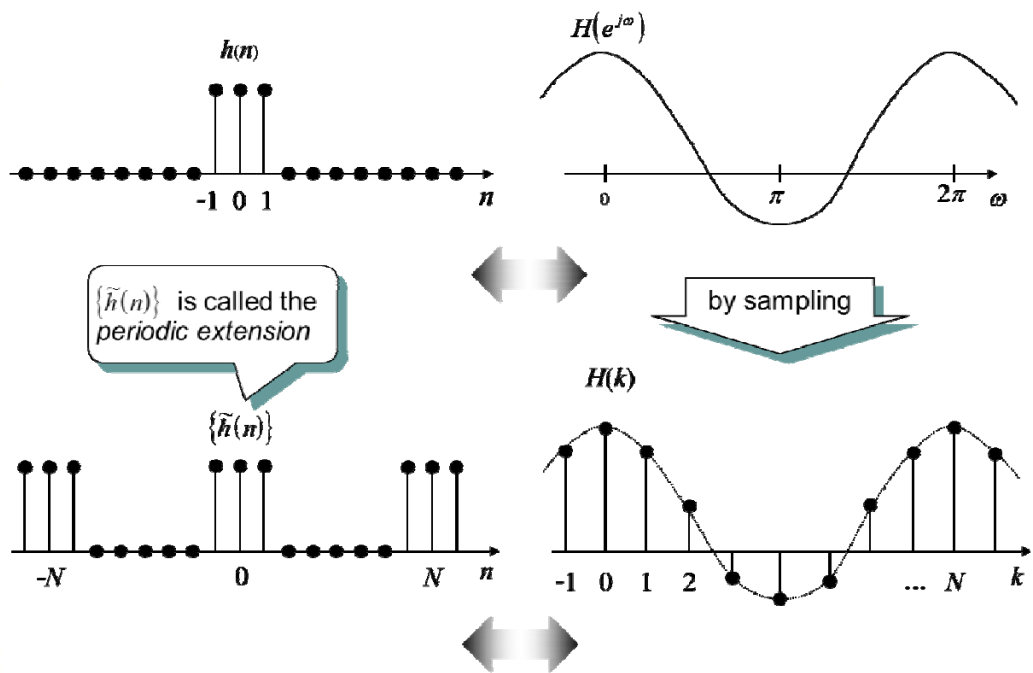
for $u = 0, 1, 2, \dots, M-1$ and
 $v = 0, 1, 2, \dots, N-1$.

2D Discrete Fourier Transform



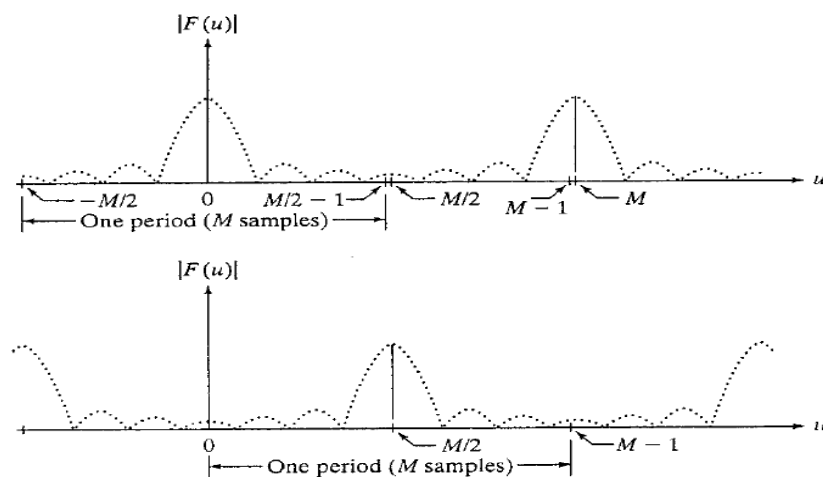
$$f(x,y) = \frac{1}{MN} \sum_{u=0}^{M-1} \sum_{v=0}^{N-1} F(u,v) e^{j2\pi \left(\frac{ux}{M} + \frac{vy}{N} \right)};$$

for $x = 0, 1, 2, \dots, M-1$ and
 $y = 0, 1, 2, \dots, N-1$.



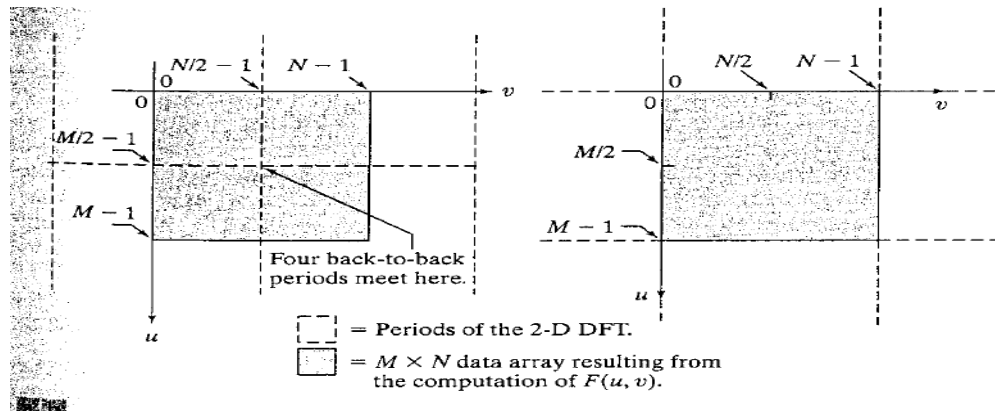
2D Discrete Fourier Transform

Periodicity property of DFT: 1-D case



2D Discrete Fourier Transform

Periodicity property of DFT: 2-D case



2D Discrete Fourier Transform

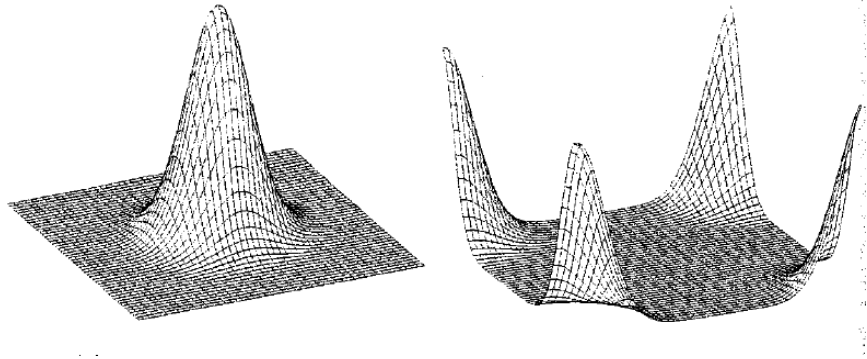
Computing and Visualizing the 2-D DFT
in MATLAB

```
>> ex4_01 % See demonstration
```




2D Discrete Fourier Transform

Computing and Visualizing the 2-D DFT
in MATLAB



Filtering in the Frequency Domain

Fundamental Concepts

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

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



Filtering in the Frequency Domain

>> ex4_02 % See demonstration



**The end of
part 1**