DIGITAL IMAGE PROCESSING-1

Unit 2: Lecture 14

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Unit 2: Image Transforms

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Last Session

- Basic relationship between pixels cont..
- Regions and boundaries
- Linear/non linear operations on images

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Today's Session

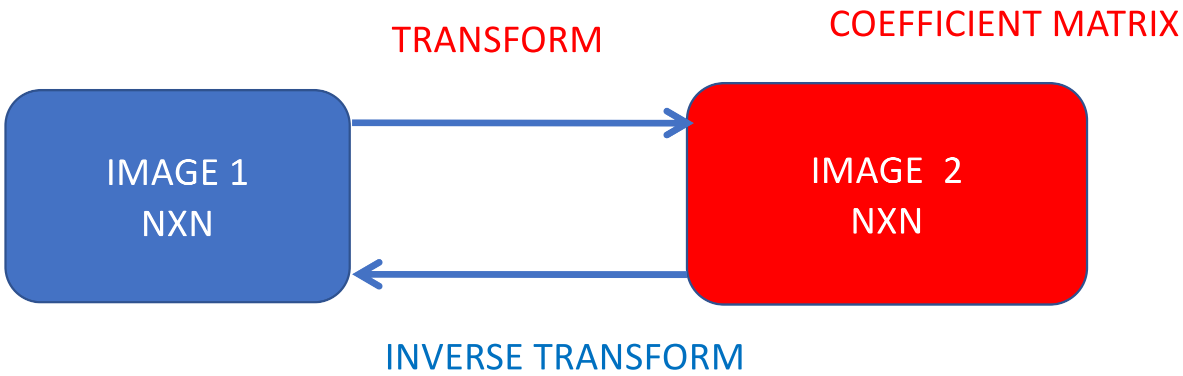
- Image transforms preliminaries
  - 2 D orthogonal transforms

Linear Transforms

- Linear transforms follow the superposition theorem (homogeneity and additive property)
- These transforms, decompose functions into weighted sums of orthogonal basis functions
  - can be studied using the tools of linear algebra and functional analysis.
- Images are vectors in the vector space of all images
- **These transforms are the coefficients of linear expansions**

Image Transforms

- All the image processing approaches discussed thus far operate directly on the pixels of an input image
  - they work directly in the spatial domain.
- In some cases, image processing tasks are best formulated by transforming the input images, carrying the specified task in a transform domain, and applying the inverse transform to return to the spatial domain. Y



- An important class of 2-D linear transforms, denoted T(u, v), can be expressed in the general form

$$T(u,v) = \sum_{x=0}^{M-1} \sum_{y=0}^{N-1} f(x,y) r(x,y,u,v)$$

where f(x, y) is an input image, r(x, y, u, v) is called a forward transformation kernel and evaluated for *u = 0,1,2,... , M− 1 and v = 0,1,2,... ,* N− 1.

x and y are spatial variables, while M and N are the row and column dimensions of f.

Variables u and v are called the transform variables.

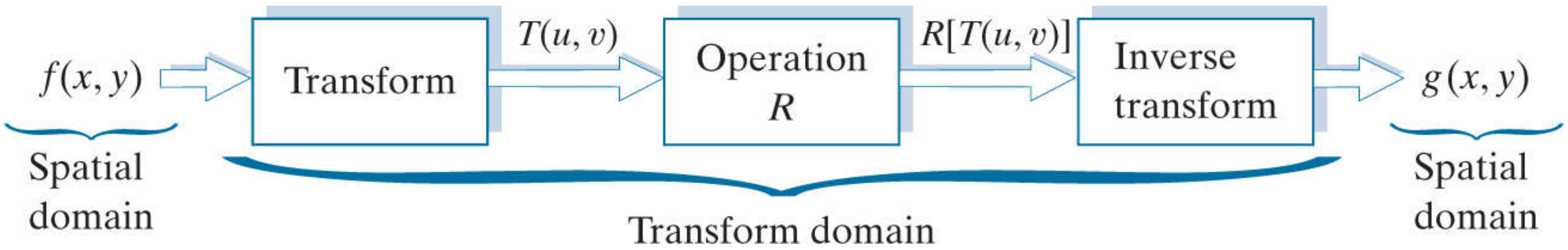
T(u, v) is called the forward transform of f(x, y)

- Given T(u, v), we can recover f(x, y) using the inverse transform of T(u, v):

$$f(x, y) = \sum_{u=0}^{M-1} \sum_{v=0}^{N-1} T(u, v) s(x, y, u, v)$$

for x = 0,1,2,... , M− 1 and y = 0,1,2,... ,N − 1,where *s(x, y, u, v)* is called an inverse transformation kernel.

- ***f(x,y)* and *T(u,v)* are called a transform pair**



General approach for working in the linear transform domain

Image Transforms

- Tools that help us to move from one domain to other

  Ex.: Time(space) to frequency
- Change of co-ordinates
- No change in information content, only representation changes
- All of an image's transforms are equivalent in the sense that they contain the same information and total energy
- They are reversible and differ only in the way that the information and energy is distributed among the transform's coefficients

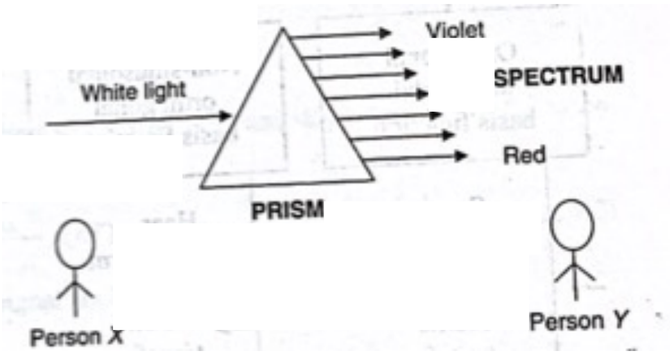
Need for Transforms

- **Fast computations/mathematical convenience-** Ex: convolutions

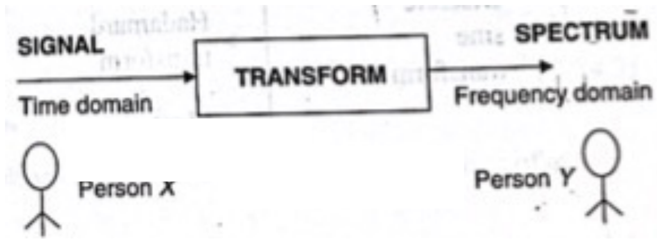
Convolution in time domain $\Longleftrightarrow$ Multiplication in the frequency domain

- **Better processing** - for smooth, moderate, fast changes in signals

- **Extracting more information-** Allow to extract more relevant information



Spectrum of white light



(Person Y gets more information)

Image Transforms

- **Two major reasons for transforming an image:**
  - The transformation may isolate critical components of the image pattern so that they are directly accessible for analysis
  - It may place image data in a more compact form so that they can be stored and transmitted efficiently

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Image Transforms

- Extensively used in image processing and image analysis
- To analyse frequency components
  - large high frequency components –more variations in short distance
  - Low frequency components are more: Smooth regions are more
- Transforms represent images as superposition of basis functions / series

  summation of set of **unitary matrices?**

Image Transforms: Applications

- Preprocessing - filtering noise (HF), enhancement
- Restoration
- Data compression
- Feature extraction-edges, corners
- Representation

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Next Session

- Image Transforms Cont..
  - 2D transforms
  - Image transforms preliminaries

THANK YOU

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