Multimedia Communications

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Multimedia communications is the field referring to the representation, storage, retrieval and dissemination of information expressed in multiple media, such as text, voice, graphics, images, audio and video.

Digital Image and Video

- With rapid computer technology advance, digital image processing gets a high attention:
  - Stereoscope for 3-D robot vision
  - Image Enhancement
  - Image Restoration
  - Image data compression
  - Segmentation
  - Image Description
  - Image Recognition
  - Document protection by watermarking

Image Enhancement

- The process of improving the quality of a digitally stored image by manipulating the image with software.

For example, to make an image lighter or darker, or to increase or decrease contrast.

Image Enhancement Before

Image Enhancement

Image Enhancement

Image Enhancement

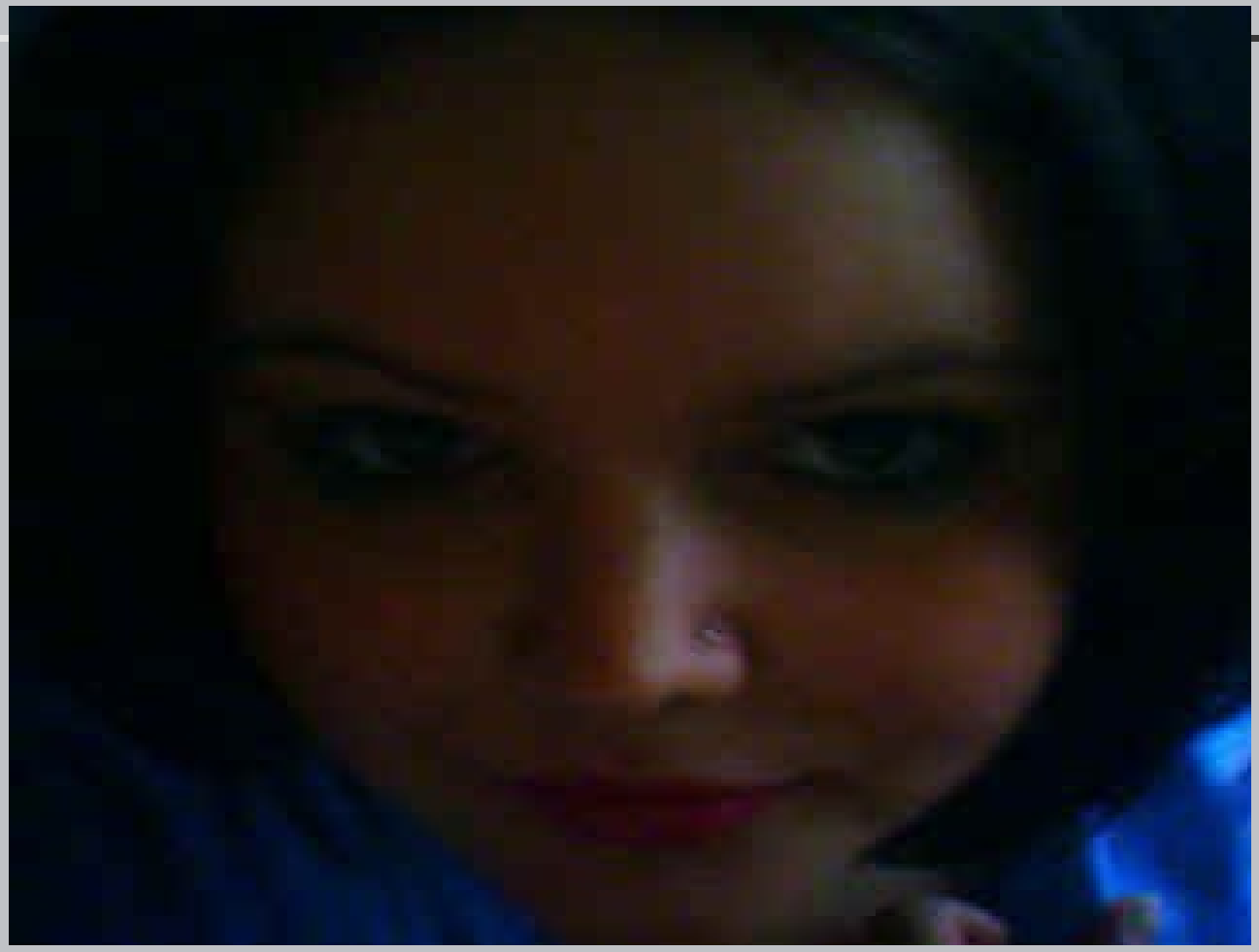


Image Enhancement

Brightness after Enhancement

Noisy Image Before

After Noise Reduction

Medical Image Noise removal

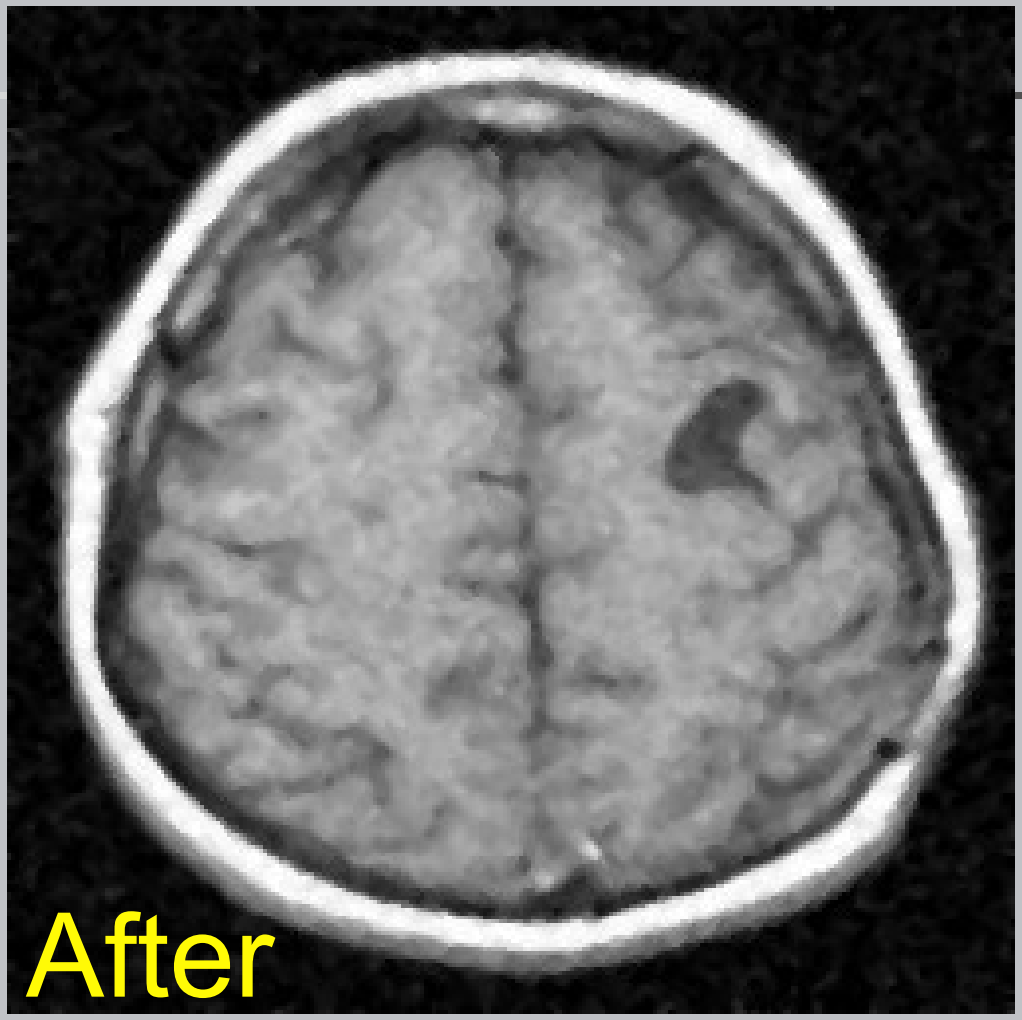


Image Restoration

- In many applications (e.g., satellite imaging, medical imaging, astronomical imaging, poor-quality family portraits) the imaging system introduces a slight distortion.

Blurred Image

Image Deblurring

Cracked Image

Restored Image

Image Data Compression

- Image data occupies a huge area of storage or transmission channel when it is used without compression.

Discrete wavelet transform

- Like DCT, discrete wavelet transform mathematically transforms an image into frequency components. The process is performed on the entire image, which differs from the other methods (DCT), that work on smaller pieces of the desired data. The result is a hierarchical representation of an image, where each layer represents a frequency band.

Discrete wavelet transform Common Applications

- Lossy data compression
- De-noising
- Detection

Compression standards

- MPEG stands for the Moving Picture Experts Group. There are five MPEG standards being used or in development. Each compression standard was designed with a specific application and bit rate in mind, although MPEG compression scales well with increased bit rates. They include:

MPEG-1

- Designed for up to 1.5 Mbit/sec Standard for the compression of moving pictures and audio. This was based on CD-ROM video applications, and is a popular standard for video on the Internet, transmitted as .mpg files. In addition, level 3 of MPEG-1 is the most popular standard for digital compression of audio--known as MP3. MPEG-1 is the standard of compression for VideoCD

MPEG-2

- Designed for between 1.5 and 15 Mbit/sec Standard on which Digital Television set top boxes and DVD compression is based. It is based on MPEG-1, but designed for the compression and transmission of digital broadcast television. MPEG-2 scales well to HDTV resolution and bit rates, obviating the need for an MPEG-3.

MPEG-4

- Standard for multimedia and Web compression. MPEG-4 is based on object-based compression, similar in nature to the Virtual Reality Modeling Language. Individual objects within a scene are tracked separately and compressed together to create an MPEG4 file. This results in very efficient compression that is very scalable, from low bit rates to very high. It also allows developers to control objects independently in a scene, and therefore introduce interactivity.

MPEG-7

- This standard, currently under development, is also called the Multimedia Content Description Interface. When released, the group hopes the standard will provide a framework for multimedia content that will include information on content manipulation, filtering and personalization, as well as the integrity and security of the content. Contrary to the previous MPEG standards, which described actual content, MPEG-7 will represent information about the content.

MPEG-21

- work on this standard, also called the Multimedia Framework, has just begun. MPEG-21 will attempt to describe the elements needed to build an infrastructure for the delivery and consumption of multimedia content, and how they will relate to each other.

JPEG

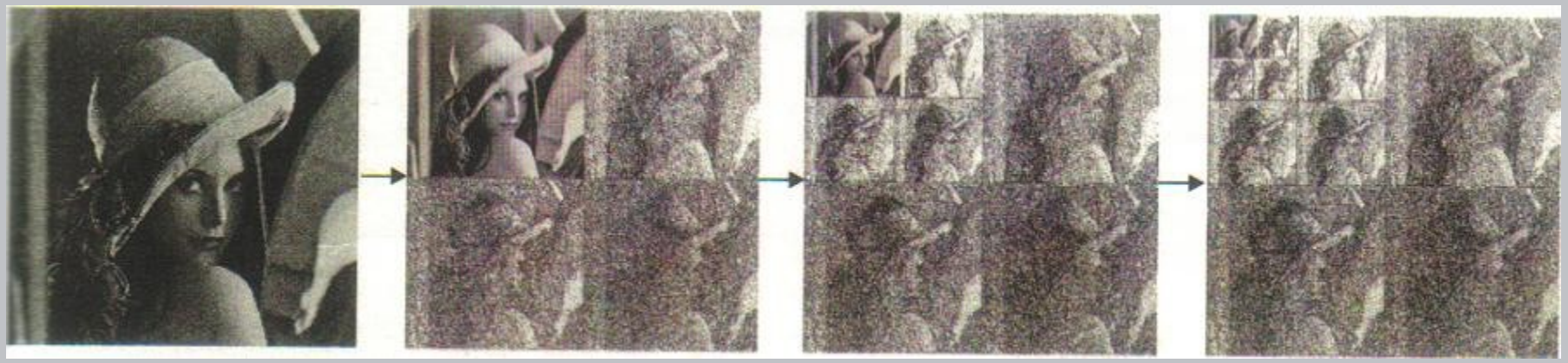
- JPEG stands for Joint Photographic Experts Group. It is also an ISO/IEC working group, but works to build standards for continuous tone image coding. JPEG is a lossy compression technique used for full-color or gray-scale images, by exploiting the fact that the human eye will not notice small color changes.

JPEG 2000

- JPEG 2000 is an initiative that will provide an image coding system using compression techniques based on the use of wavelet technology.

Wavelet Transform

- Convolution based filtering
- Lifting based filtering



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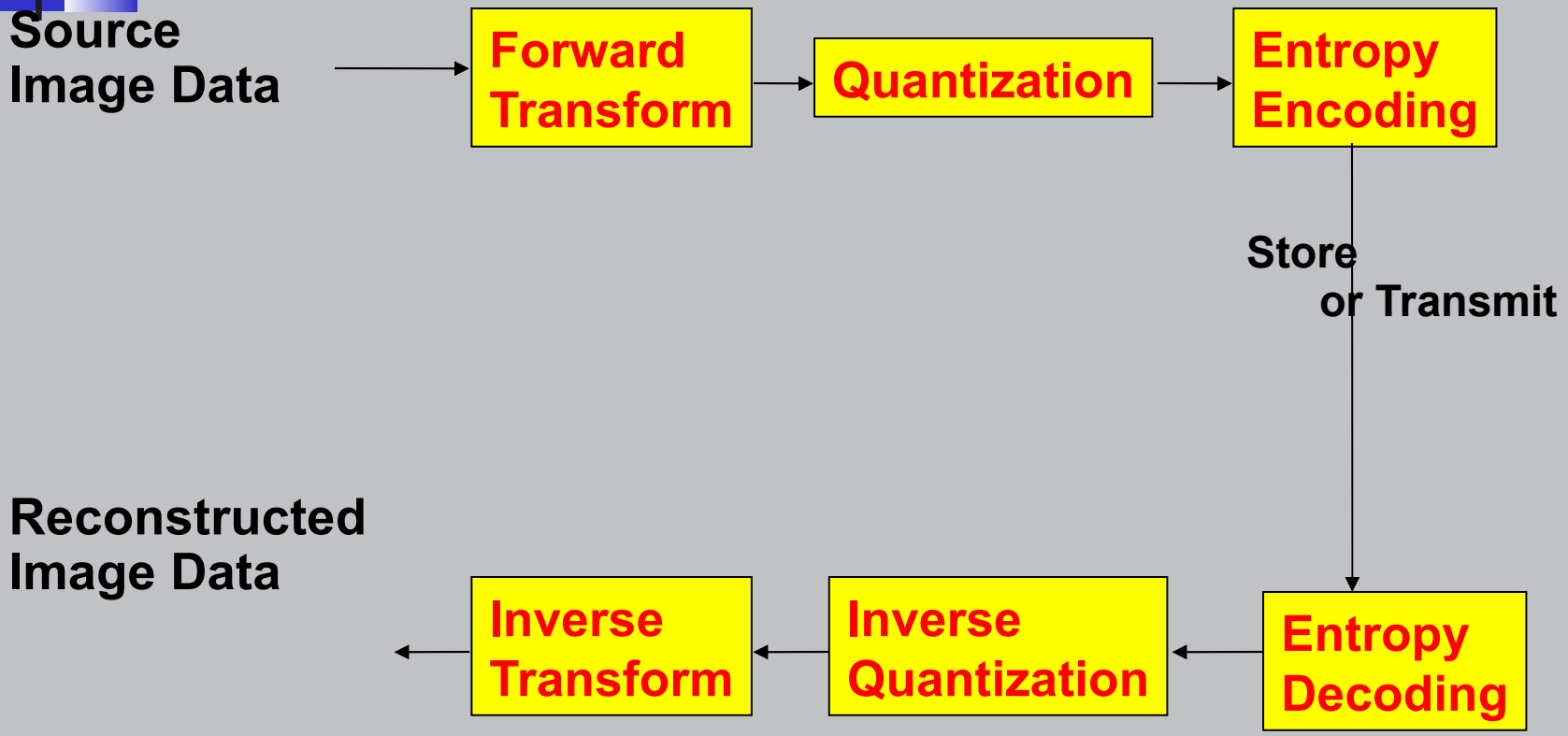
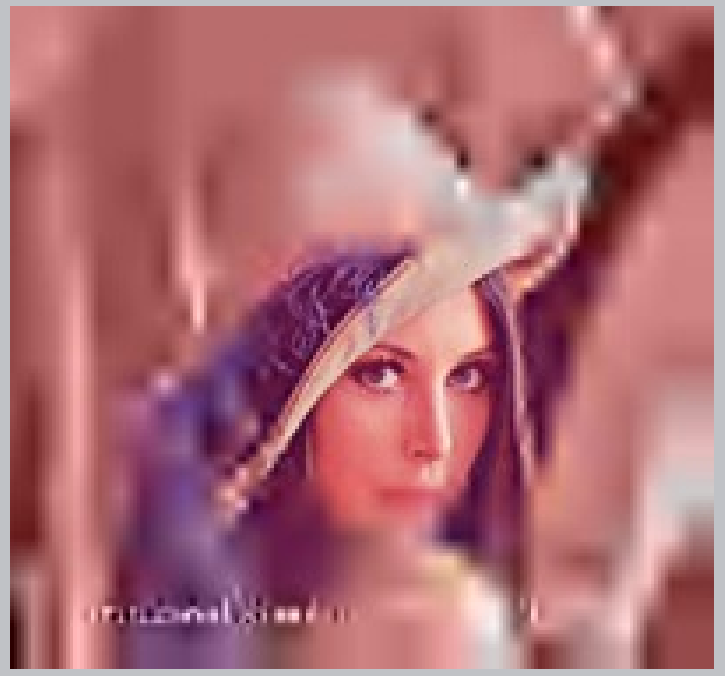
General block diagram of the JPEG 2000



ROI (Region of interest)

Often there are parts of an image that are more important than others. This feature allows users to define certain ROI's in the image to be coded and transmitted with better quality and less distortion than the rest of the image.

Example of ROI mask



Example of JPEG2000

Reconstruction image “ski” after compression at 0.25 b/p by means of (a) JPEG (b) JPEG 2000.

Image Segmentation

- Segmentation is to distinguish objects from background.

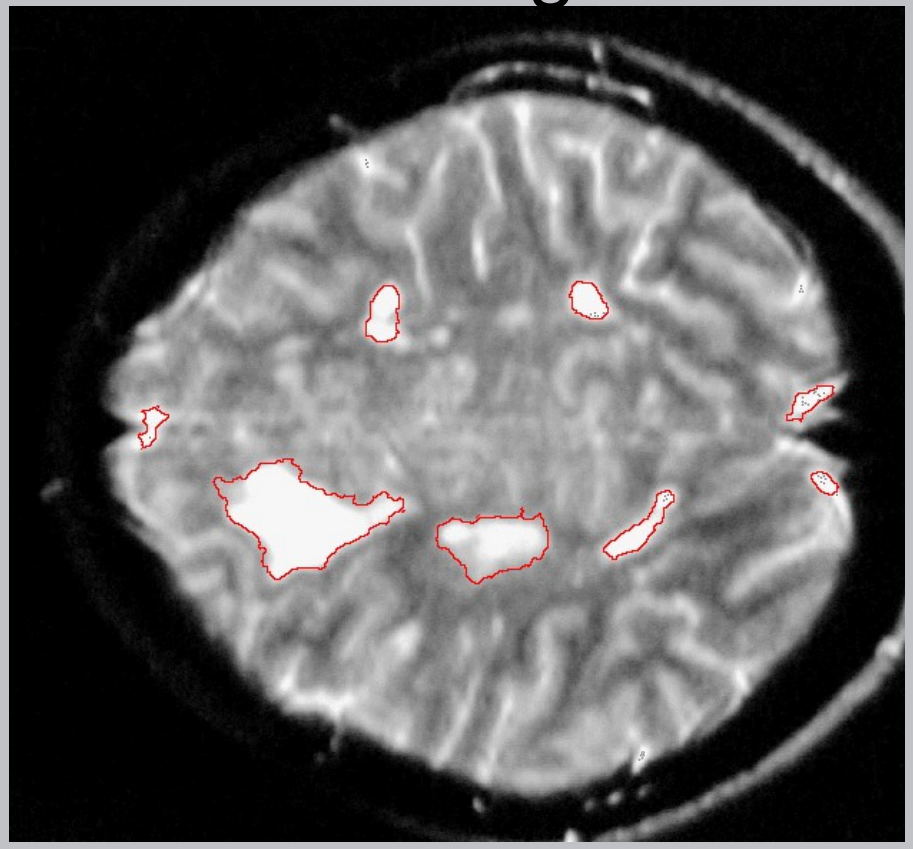


Image Segmentation

There are four techniques for image segmentation:

- Threshold techniques
- Edge-based methods
- Region-based techniques
- Connectivity-preserving relaxation methods

Threshold techniques

- Threshold techniques, which make decisions based on local pixel information, are effective when the intensity levels of the objects fall squarely outside the range of levels in the background. Because spatial information is ignored, blurred region boundaries can create havoc.