An Introduction Data Compression

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Lecture Outline

Image Compression

Types of redundancy and how to remove each types

A-interpixel

B-coding

C-psychovisual (Human Visual System)

Image Compression

A picture is worth a thousand of words.

In the early stages of our lives, pictorial learning plays an important role in understanding everything around us.

Types of Redundancy

Why is it possible to compress images?

Statistical

Psychovisual

Coding

Correlation

Interpixel, Spatial, Intraframe

Interpixel redundancy (statistical)

This type is due to the local similarity, or correlation (statistical dependency),

between an image pixel's value and its neighbours' (i.e., as the name implies, the similarity or repetition between pixels, where neighbouring pixels are not independent but correlated).

High correlation among neighbor pixels, Pixel values are not spatially independent

150	150	150	150	150	150	150	150
150	150	150	150	150	150	150	150
150	150	150	150	150	150	150	150

Simply the similarity among most neighboring pixels within image

Coding redundancy (statistical)

To convert the continuous sensed data into digital form, we have to sample the function in both coordinates and in amplitude. Digitizing the coordinate values is called sampling (i.e., discretize an image in the spatial domain). Digitizing the amplitude values is called quantization, in other words a process of making a continuous function discrete consists of two step process:

1) Sampling and 2) Quantization

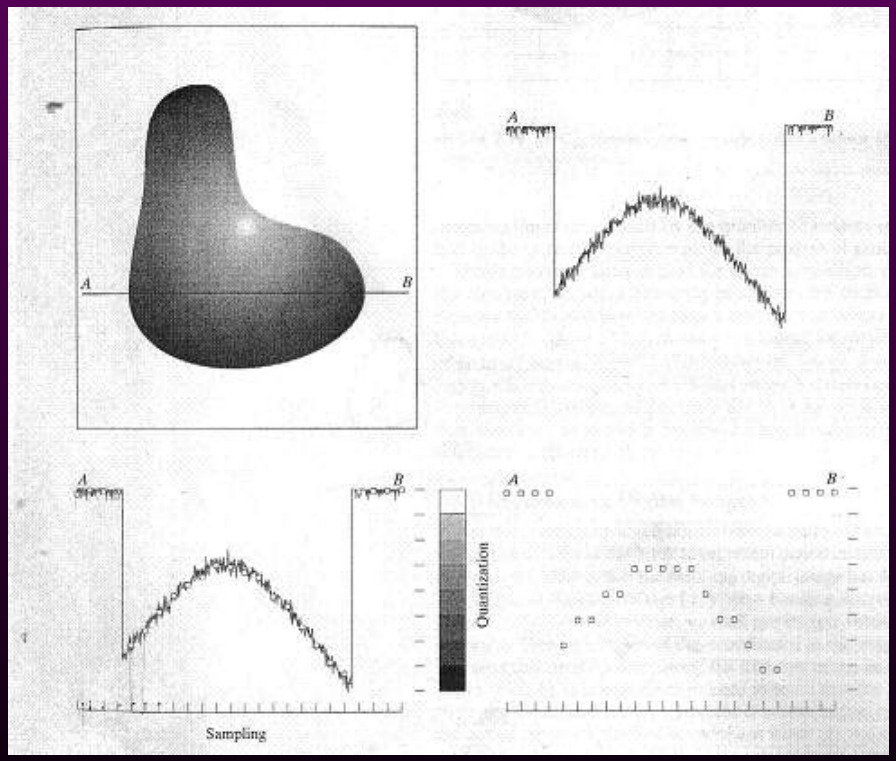
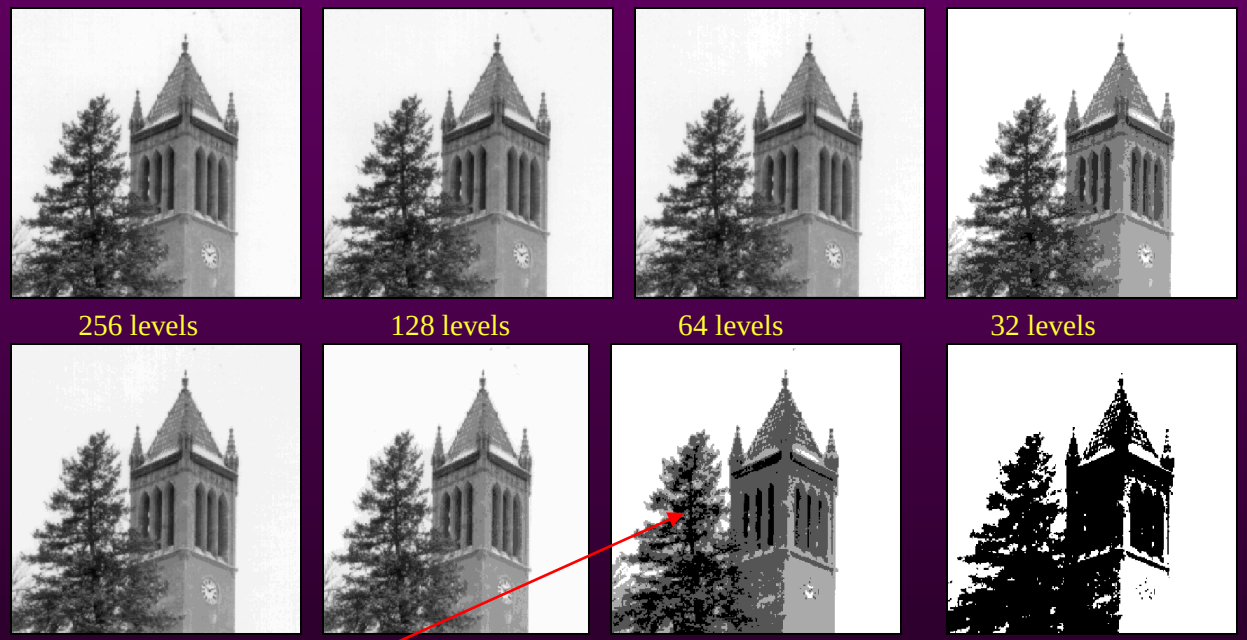


Figure: Generating a digital image. (a) continuous image (b) a scan line from A to B in the continues image, used to illustrate the concepts of sampling and quantization (c) sampling and quantization (d) digital scan line.

0	000
1	001
……	
7	111

Coding redundancy (statistical)

We have a quantization error because Some information is lost, also If we use small number of gray levels the false contouring phenomenon occur



In this image,

it is easy to see

false contour.

Quantization process

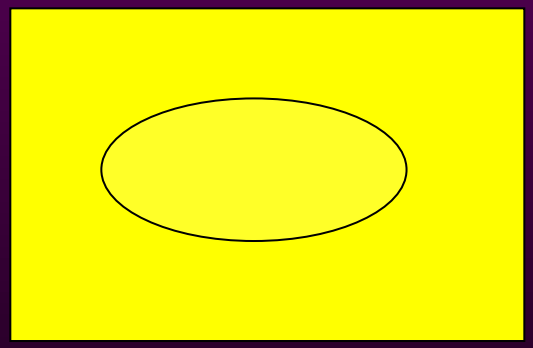
Coding redundancy (statistical)

The coding redundancy it has nothing to do with information redundancy but with the representation of information, later it changes from the fixed length coding into variable length coding.

Belongs to the way of the image values represented. The values stored using the fixed length binary coding numbers (BCN) of 0’s and 1’s, which can be altered into variable length coding by utilizing the probability of occurrence.

Psycho-visual redundancy

This type is due to the limitations of human eye sensitivity to visual information. It arises because the eye uses a subjective form of evaluation, characterized by its vast power for perceiving the overall image structure, but with the corresponding loss of being able to perceive each detail (pixel) separately. This presents the opportunity to remove imperceivable differences in image details



Belongs to nature of the human eye, since the eye cannot recognize if this pixel for example is 177 or 176 or 178 because it's difficult (impossible) to the eye to see these tiny differences, the utilization of this fact leads to eliminating these small differences and preserving the important information.

Psycho-visual redundancy

256 levels

128 levels

64 levels

32 levels

16 levels

8 levels

4 levels

2 levels

In this image,

it is easy to see

false contour.

Quantization process

Human Vision System Characteristics

HVS composed of 2 parts:

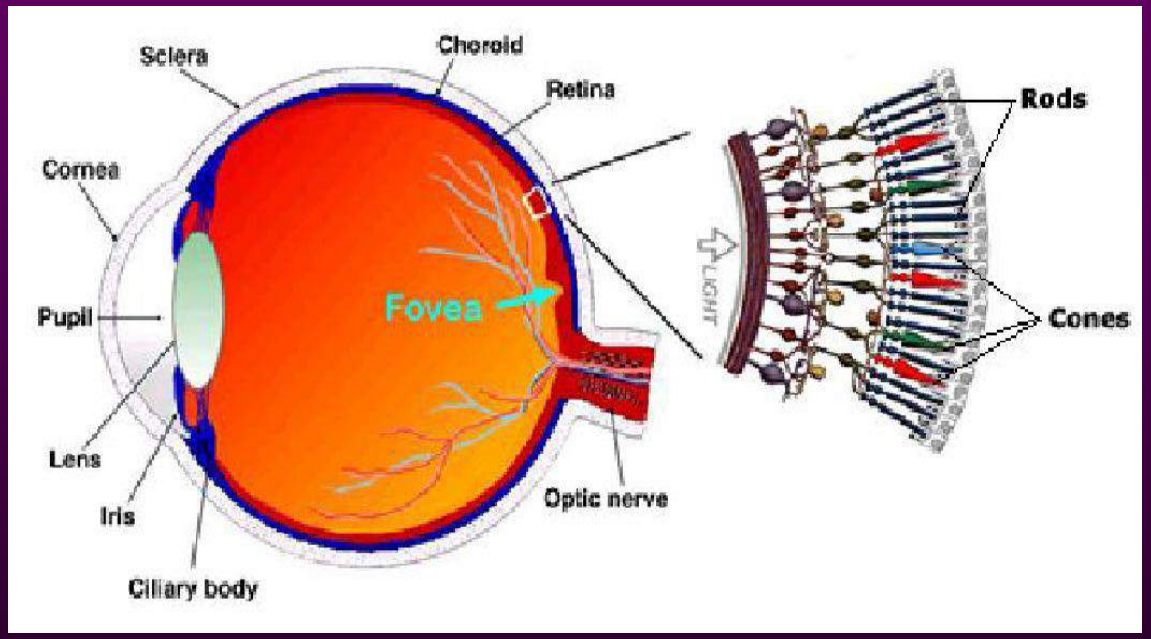
eyes &brain

Capture light (by eye)& converted into signals transmitted to the brain

When light hit eyes, goes through

cornea (transparent protective layer, which acts as a lanes & refract light)

In retina, the lights are detected & converted into signals by photoreceptors, the eye has 2 types of photoreceptors: rods & cones named after their approximate shape



Human Vision System Characteristics

Rods

-about 100 millions in the eye

-not color sensitive

-spread evenly about the retina, except at the center (fovea)

-gives general overall picture (not details)

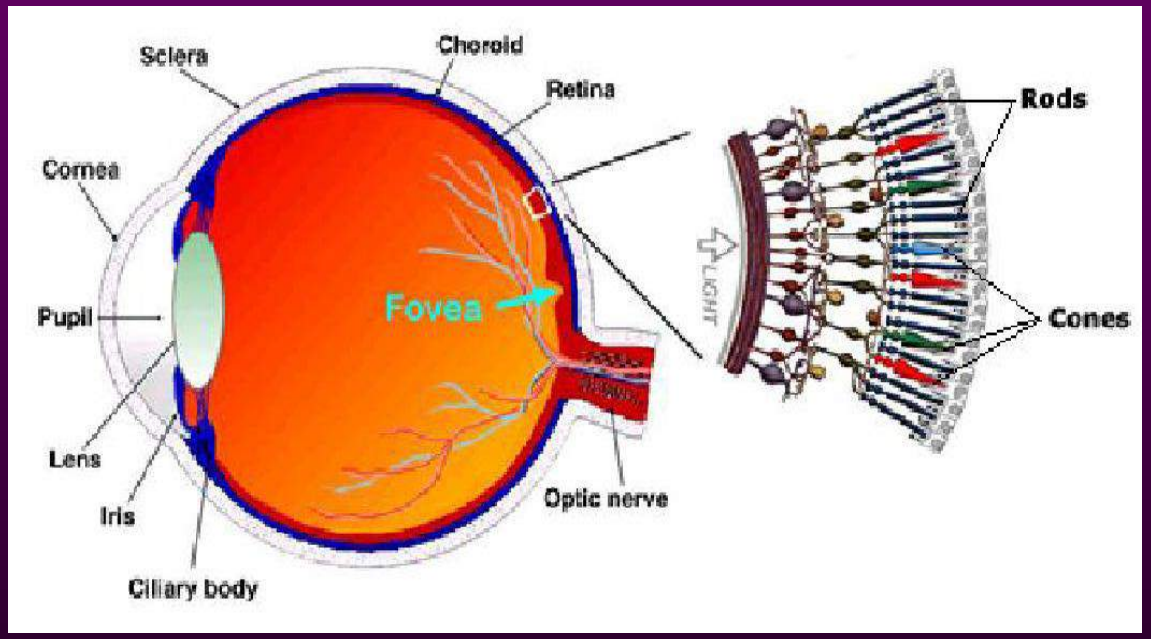
Cones

-about 6-7 millions in the eye

-color perception

-located around the fovea

-we are able to distinguish colors (3 main types RGB)



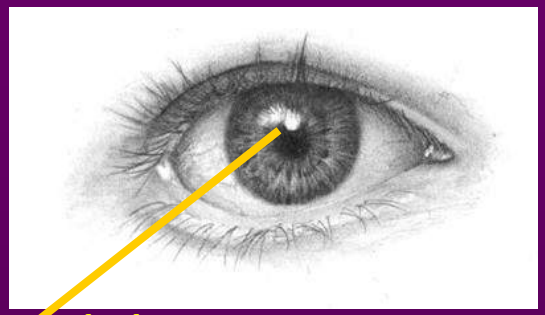
Psycho-visual redundancy

The psychovisual redundancy is related to the information that is psychovisually redundant (originates from the characteristics of the human visual system), i.e., to which the HVS is not sensitive.

Visual information is not perceived equally; some information may be more important than other information. This implies that if we apply fewer data to represent less important visual information, perception will not be affected. In this sense, we see that some visual information is psychovisually redundant It can be eliminated without significantly impairing the quality of image perception . Eliminating this type of psychovisual redundancy leads to data compression .

Statistical redundancy in terms of spatial and coding redundancy

128 128 128
128 128 128



Subjective redundancy

Is this pixel value equal to 155 or 156 or 145?

128 128 128 128

. . .

10000000 10000000 10000000

8 bits per pixel value