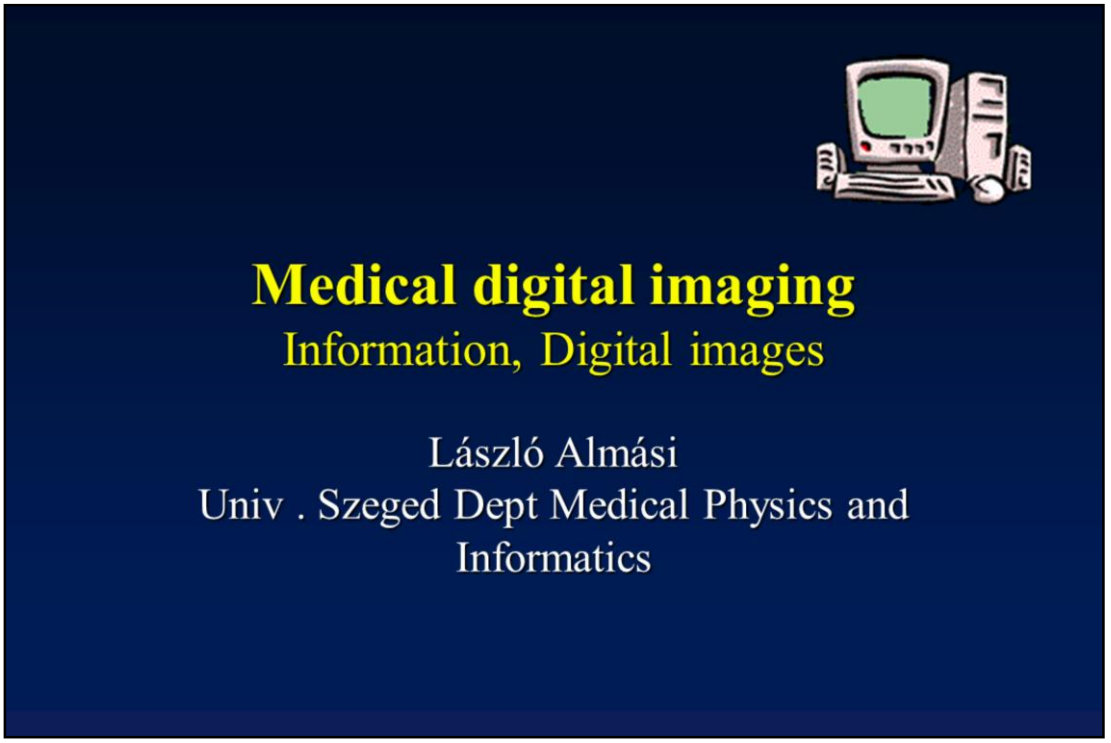
Medical digital imaging
Information, Digital images
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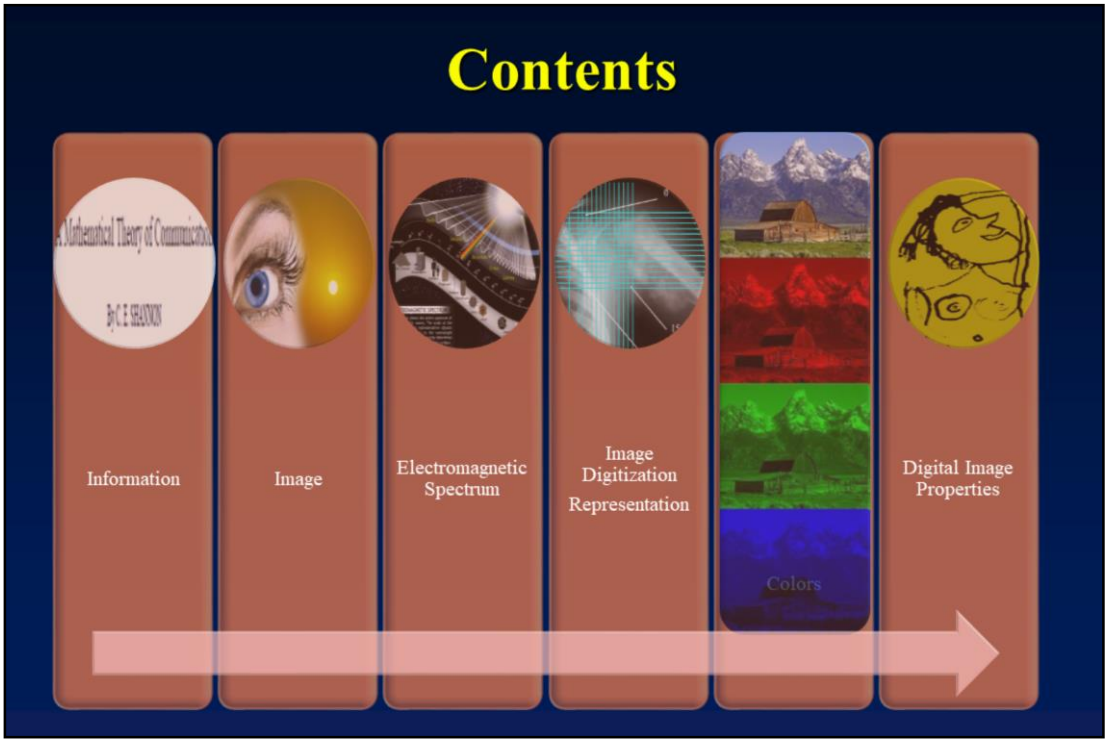
2019.9.17



In this lecture we will discuss:

- information
- images,
- images from the different part of electromagnetic spectrum,
- basics of image digitization and representation
- including colors
- and image properties

Are the following two disclosures information for you?

1

2

The color of the lecturer's hair is brown.

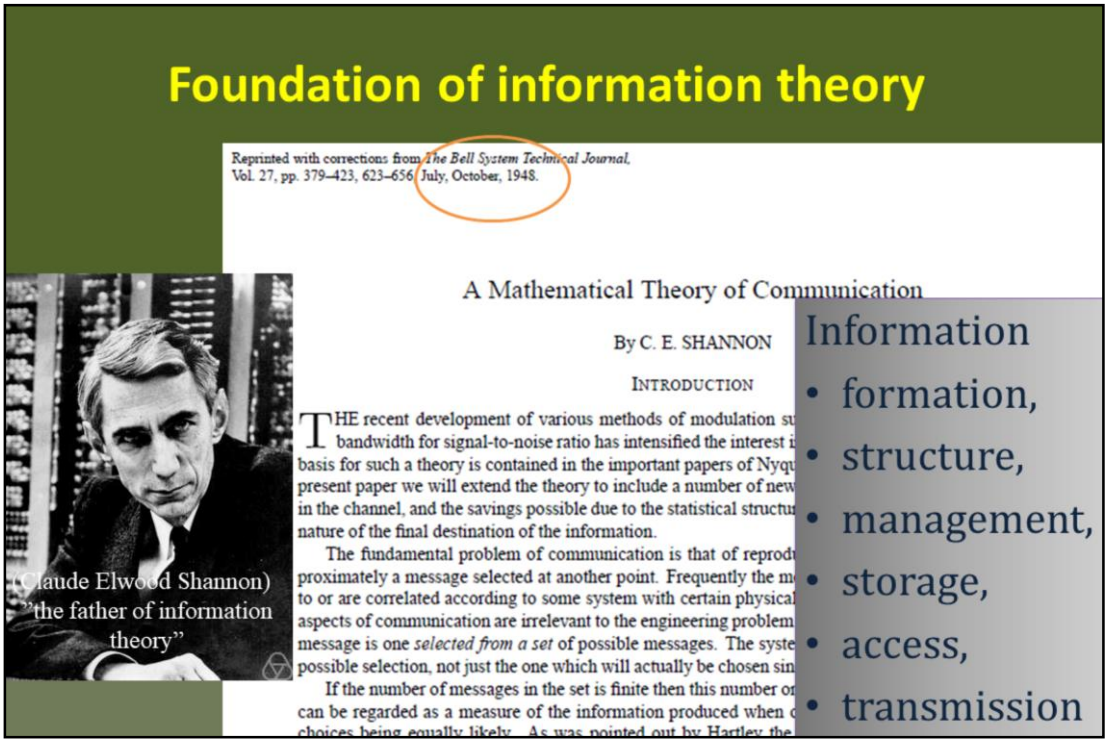
Information is the fundamental concept of the informatics.

Diverse definition lives in everyday life, in which common is, that the information:

- reduces uncertainty
- carries new knowledge
- is needed

Information is what you get when your uncertainty about sg is reduced. When your uncertainty is decreased then you receive information.

The basic unit of information is bit, 1 bit of information resolves 50% uncertainty.
When you flip a fair coin you are uncertain whether it lands on head or tail. When it lands you can see what side it landed, your uncertainty is gone, the side of the coin landed gives information.

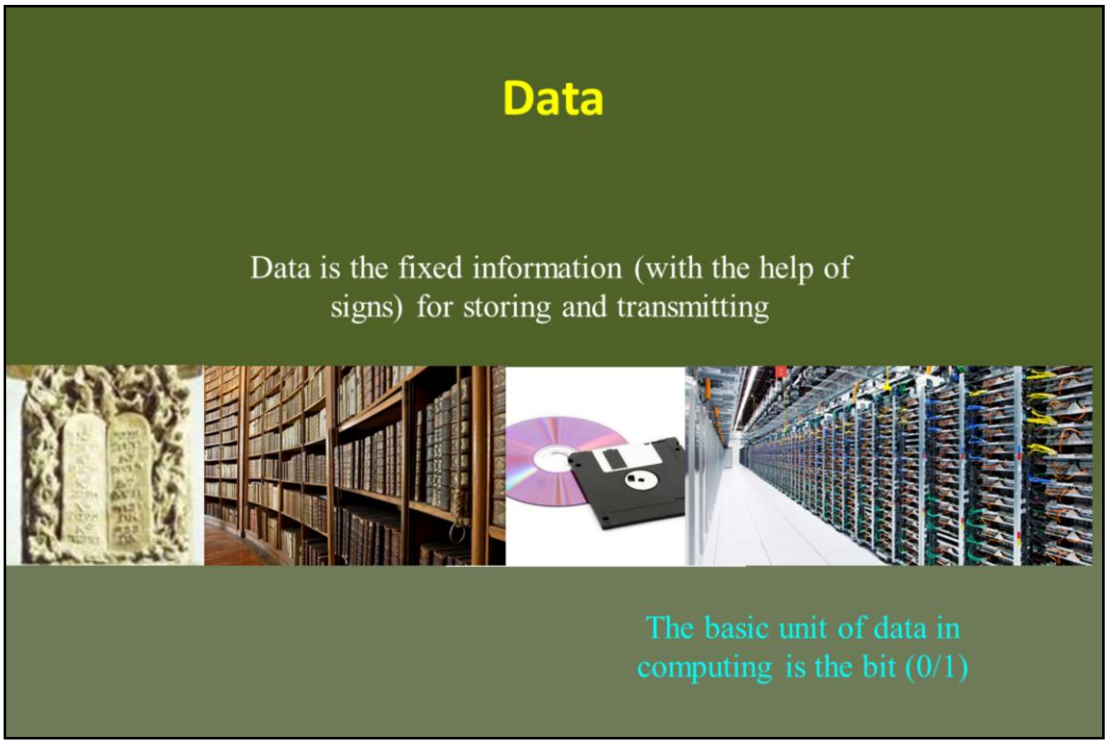


Claude E. Shannon's article, the foundation of information theory.
The information theory is a science area dealing with data that is understood as a new knowledge. It mainly deals with the formation, structure, management, storage, access and transmission of information.
Information theory also studies the different uses of information, information systems.

They are not:

1: We can perceive but we can't understand.

2: We sense, understand, but it does not matter to us or it does not contain new knowledge.



The knowledge acquired will be stored in some way. We forget and die.

Data is the fixed information with the help of signs for storing and transmitting.

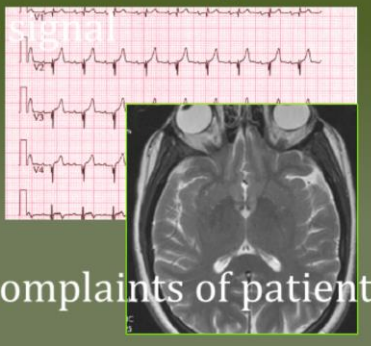
The basic unit of the data in computing is the bit. It is the amount of information stored by a digital device (data).

In information theory one bit is the uncertainty of a binary random variable that is 0 or 1 with equal probability (or the information that is gained when the value of such a variable becomes known).

Basic type of information

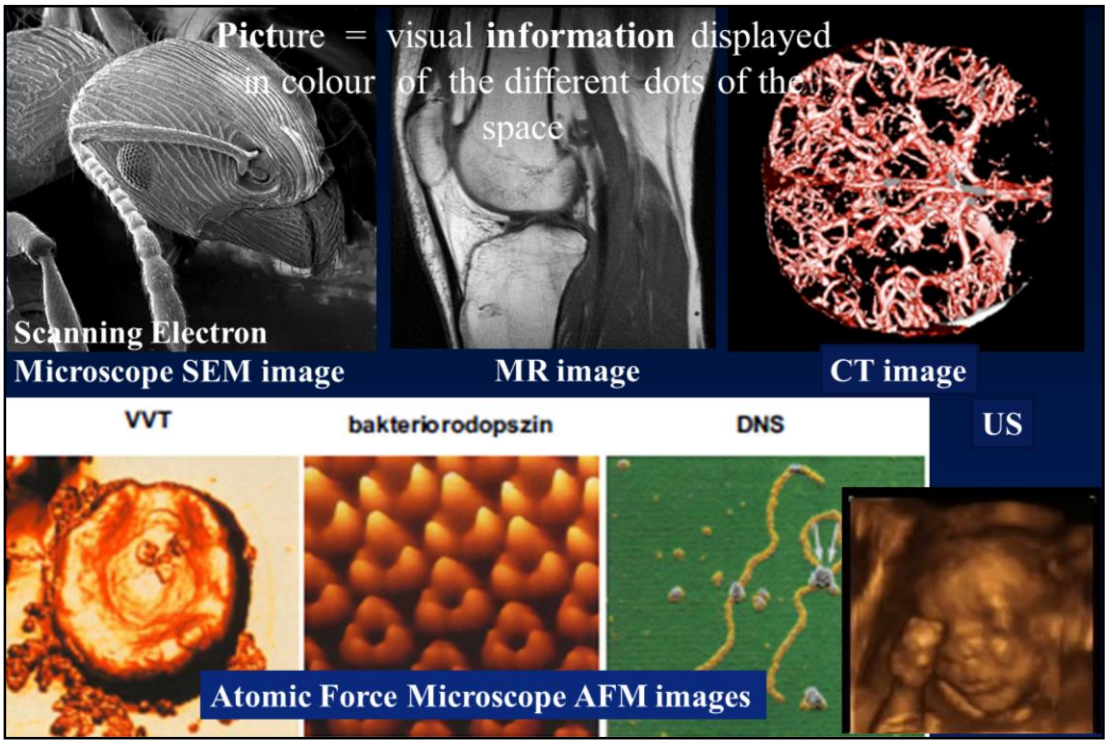
In the health domain, according to the type of sign carrying the information:

- Numeric
  Eg. 38,7 C^0, 136/86 Hgmm
- Analogue signal
- **Image**
- Texts
  reports, complaints of patient



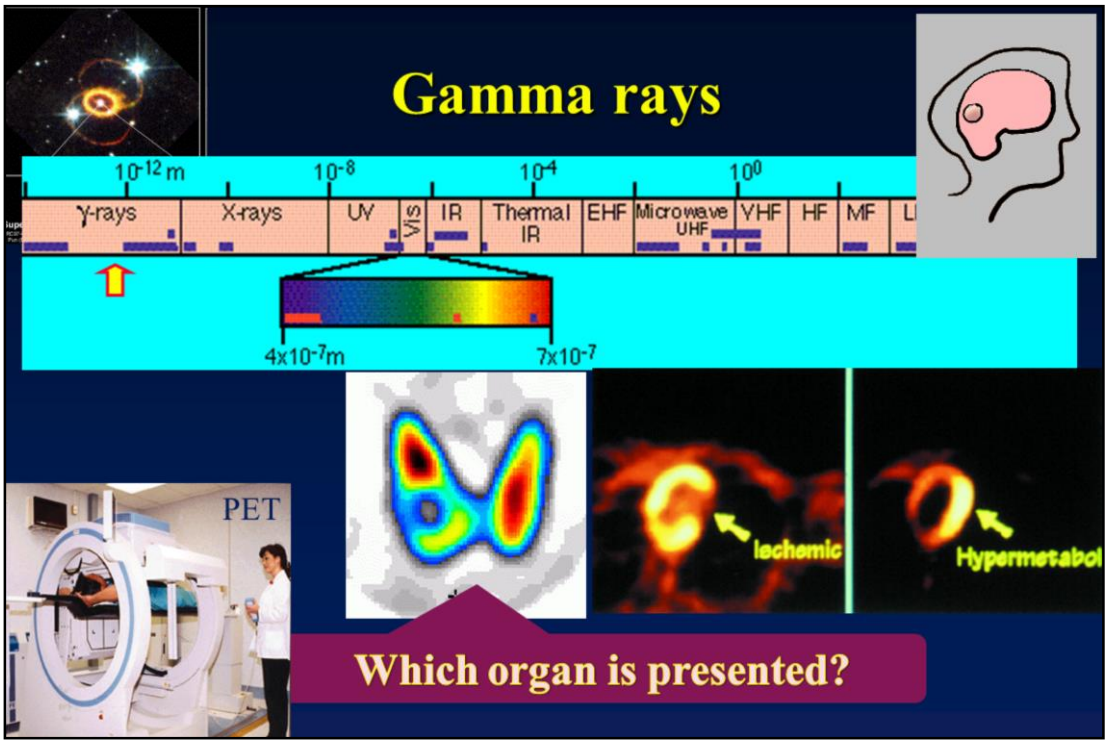
Video

Sound



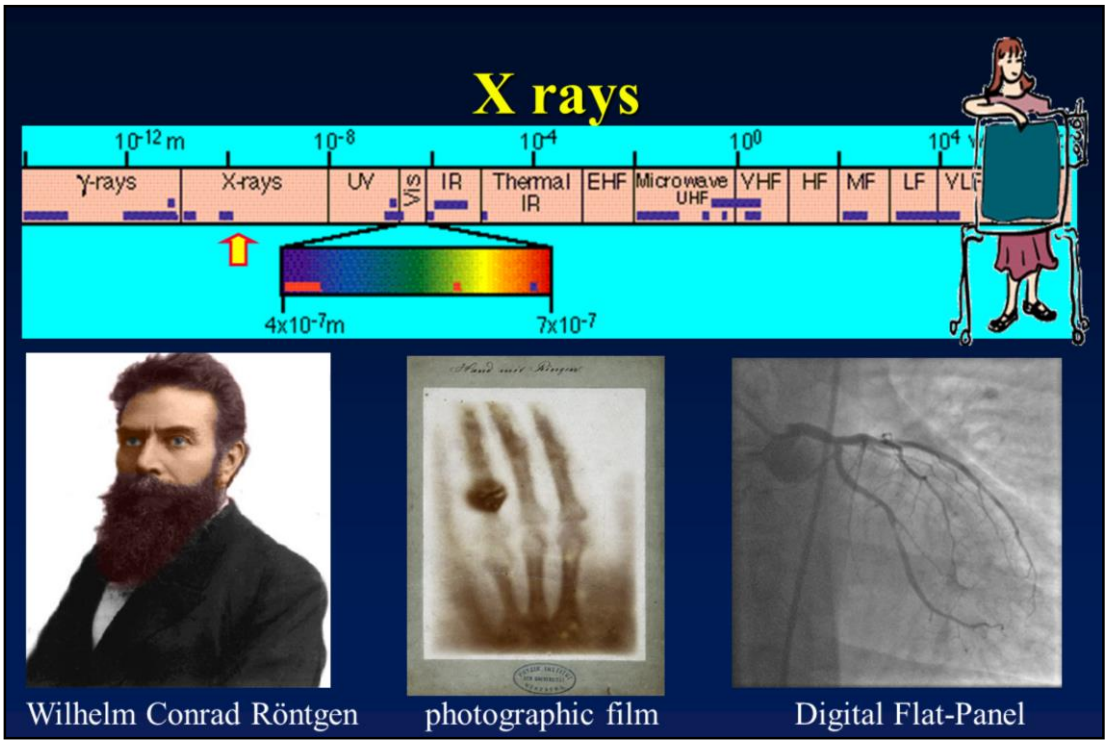
Picture is **visual information** displayed in colour or greyscale of the different dots of the space.

Here information means any signs which can be converted into electric potential (intensity, concentration, relaxation time, absorption, force, sound, etc.)



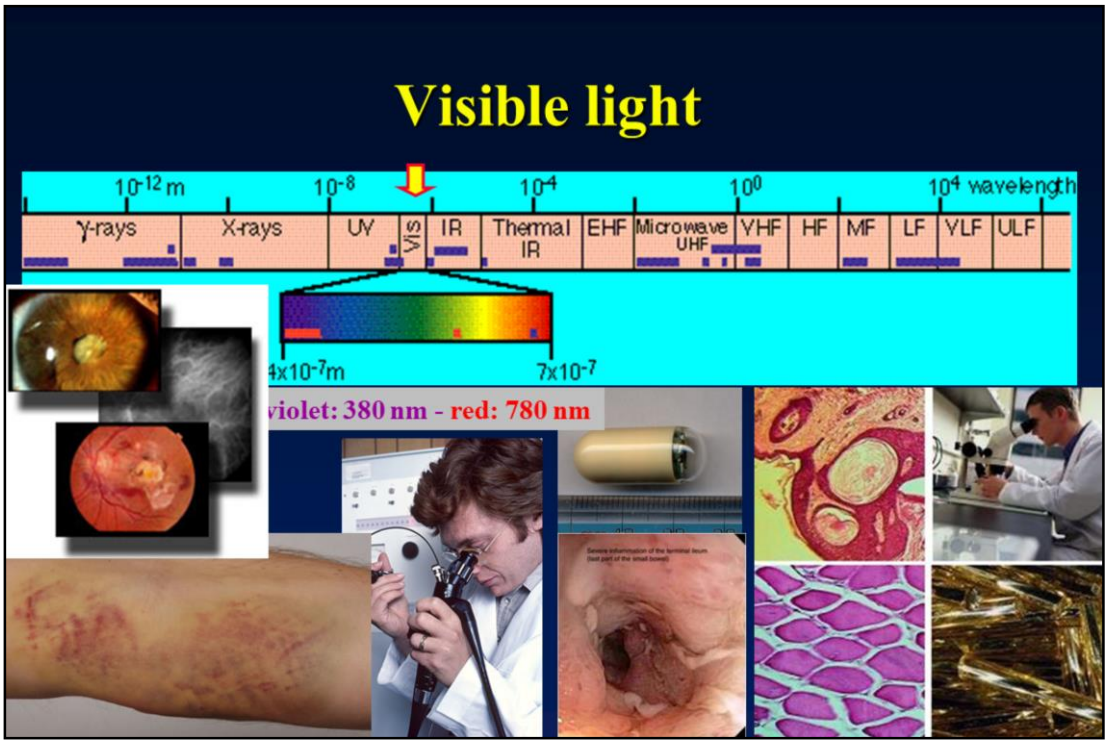
All of the electromagnetic radiation can be arranged by frequency (wavelength, energy) in this way we get the electromagnetic spectrum.

Gamma rays is electromagnetic radiation of high frequency (very short wavelength). Medical diagnostic, Nuklear medicine. SPECT, PET



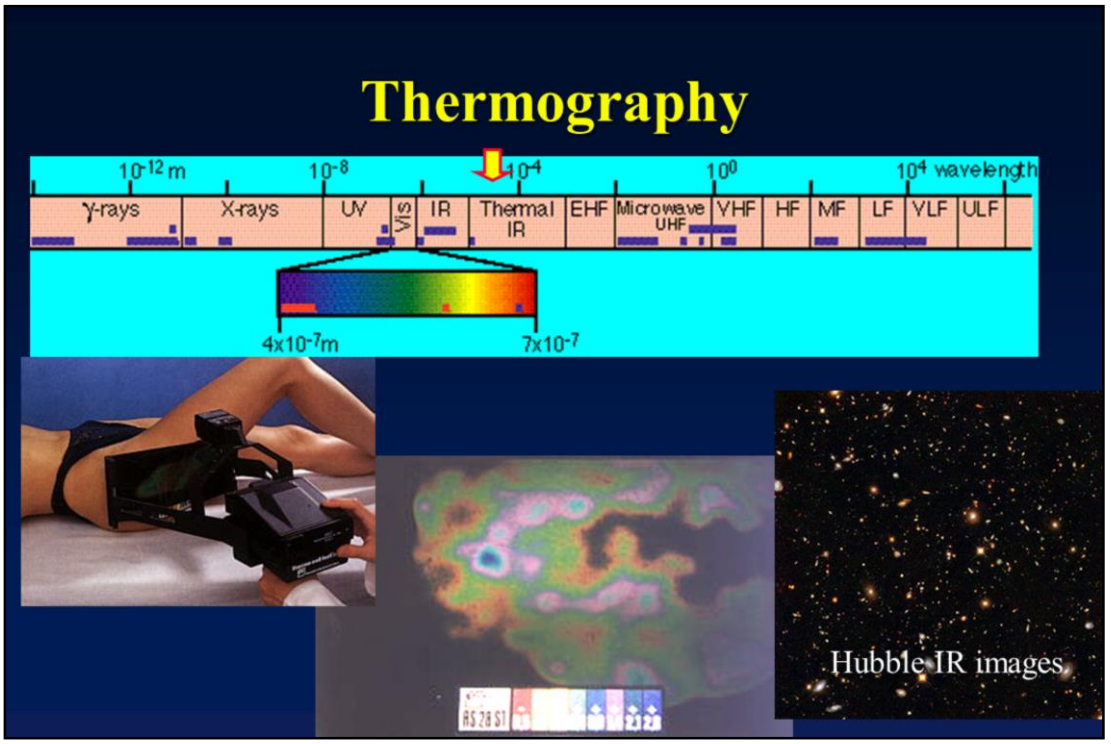
X-rays can penetrate solid objects, and their most common use is to take images of the inside of objects in diagnostic radiography.

Digital radiography is a form of X-ray imaging, where digital X-ray sensors are used instead of traditional photographic film.



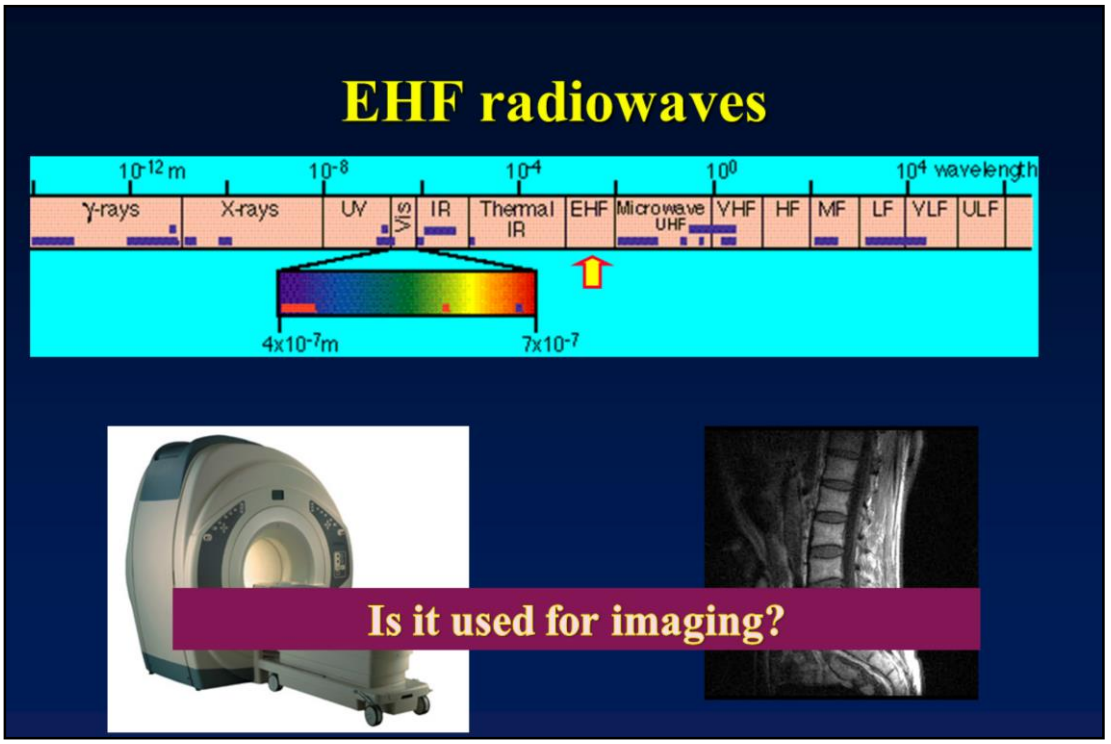
The electromagnetic radiation between 380 nanometer and 780 nanometer wavelengths is called light which can be seen for the human eye.

Ophthalmic Photography, Medical photography, Endoscopy, Capsule Endoscope, light microscophy.



This is the "thermal imaging" region, in which sensors can obtain a completely passive picture of the outside world based on thermal emissions only and requiring no external light or thermal source such as the sun, moon or infrared illuminator.

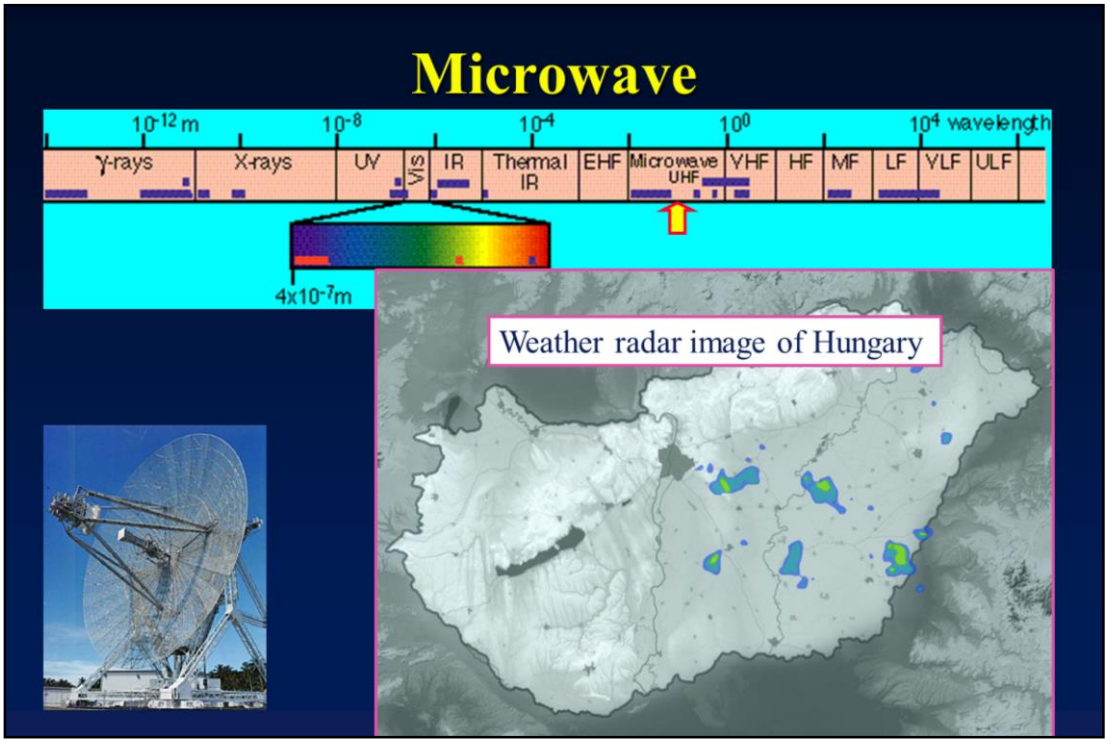
Hubble IR images, remote temperature sensing,



Extremely high frequency is the highest radio frequency band.

The Super High Frequency (SHF) and Extra High Frequency (EHF) of microwaves come next up the frequency scale.

MRI

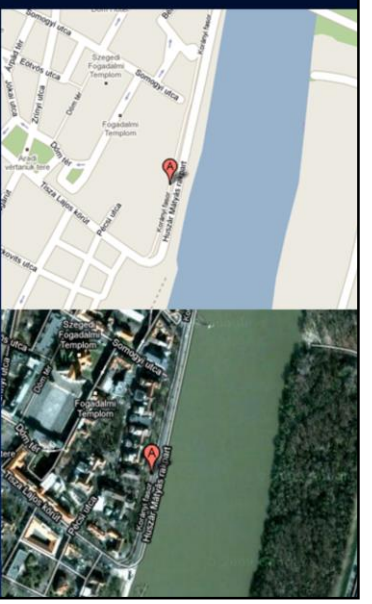


Weather radar use microwave radiation

Digital image types

- **Vector images**
  mathematical formulas
  (circles, rectangles, lines, …)
  are currently treated as separate figures
  (maps, drawings, MS Office clipart, ...)

- **Raster or bitmap images**
  finite set of digital values (picture elements or pixels)

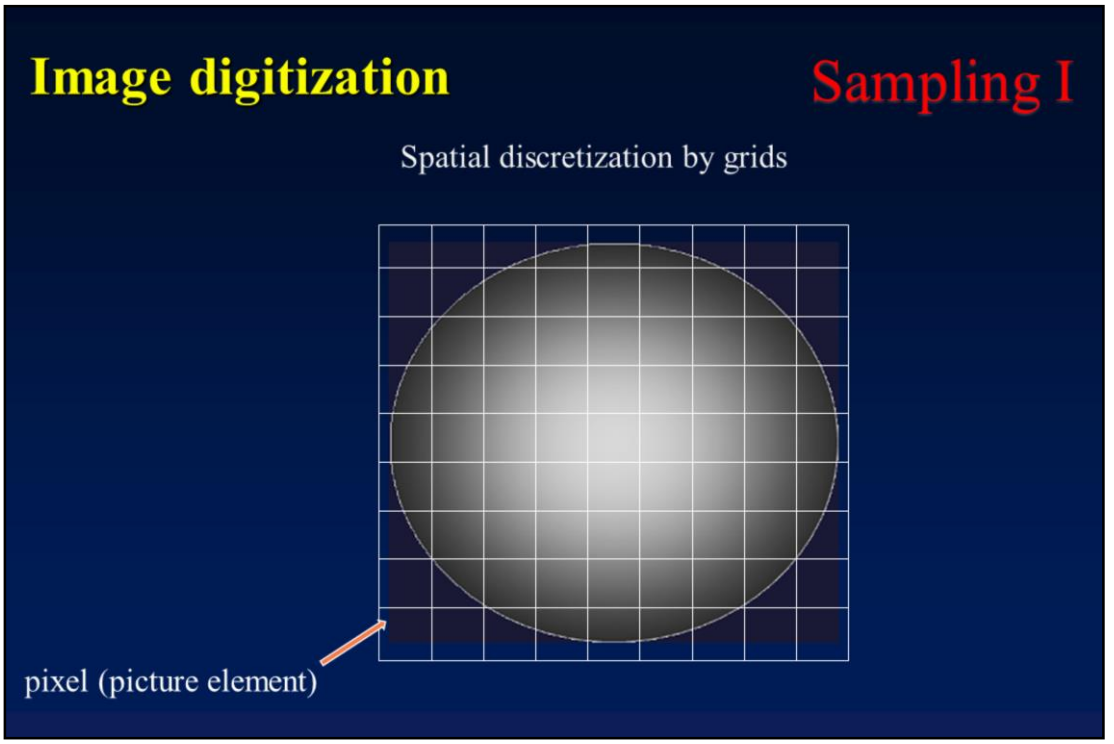


Depending on whether or not the image resolution is fixed, it may be of vector or raster type. Without qualifications, the term "digital image" usually refers to raster images also called bitmap images.

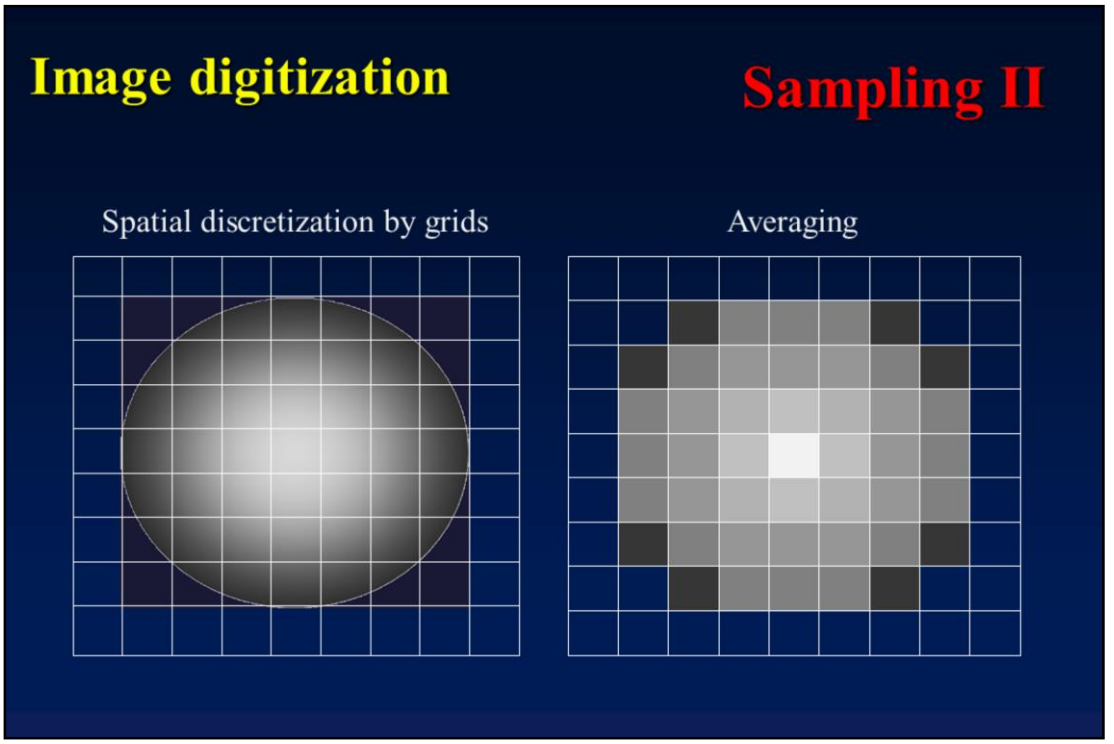
Raster images have a finite set of digital values, called picture elements or pixels. The digital image contains a fixed number of rows and columns of pixels. Pixels are the smallest individual element in an image, holding quantized values that represent the brightness of a given color at any specific point.

The magnification is the most prominent difference.

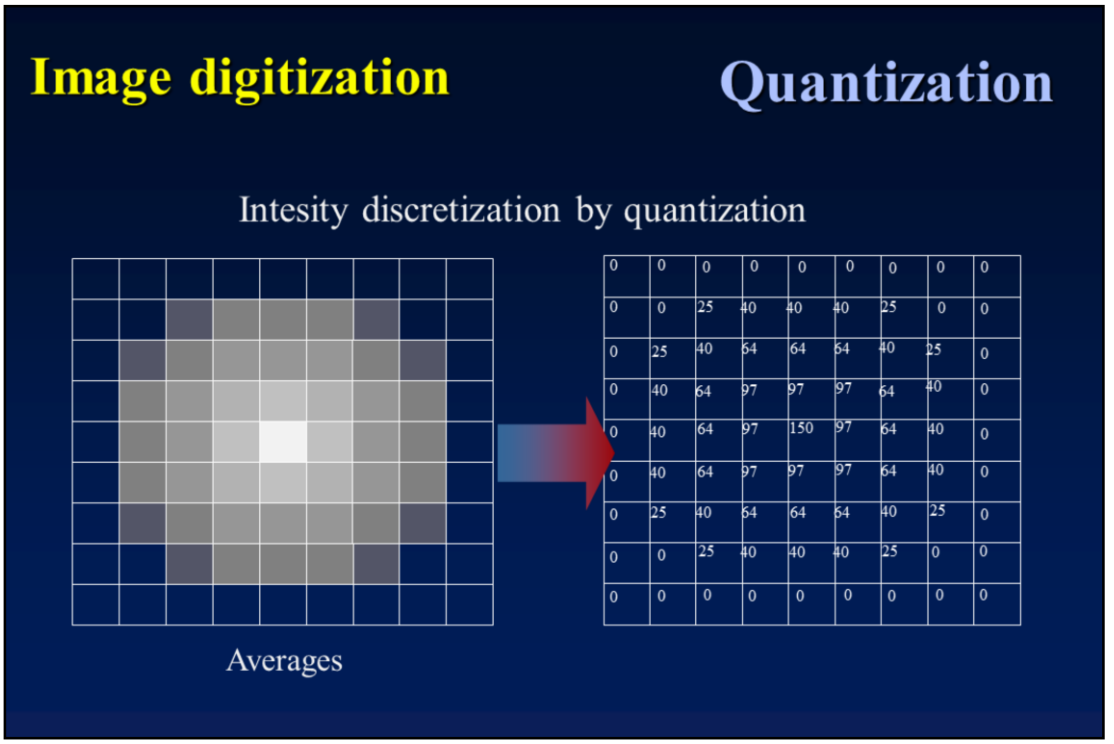
The pixel graphic picture does not disintegrate into dots because the magnification here contains a smoothing, the vector graphic picture can be magnified any times (see Google Map)



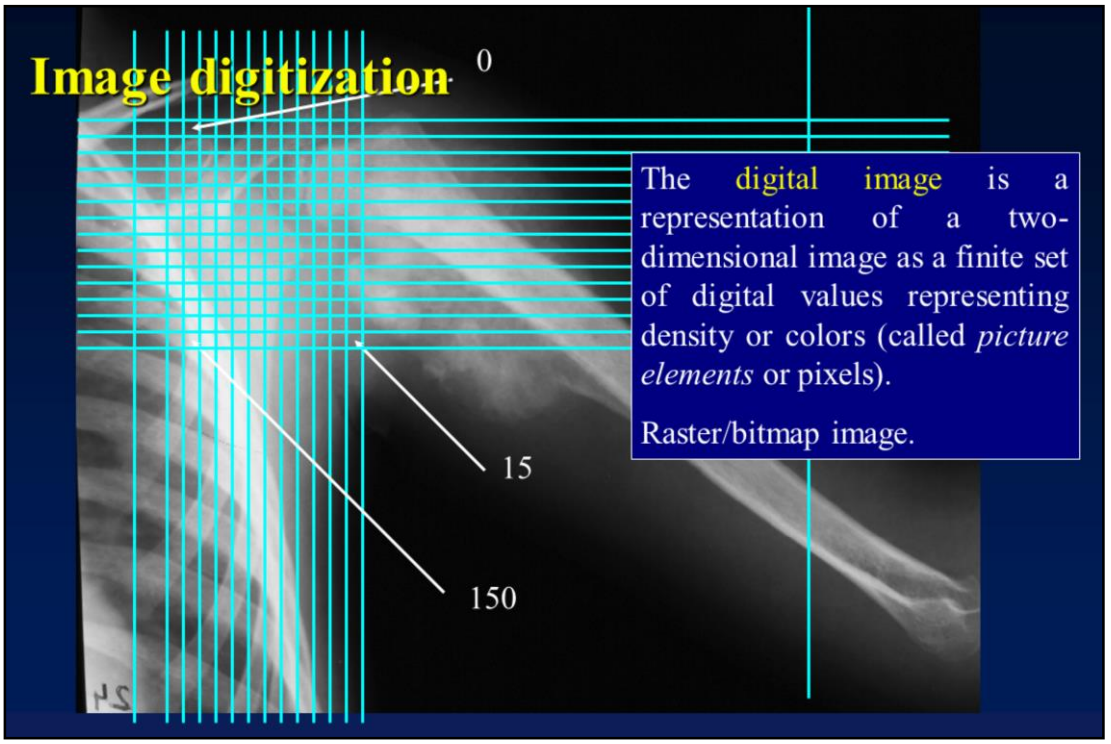
Sampling is a spatial discretization of the image by grids. One element, dot is called pixel (picture element).



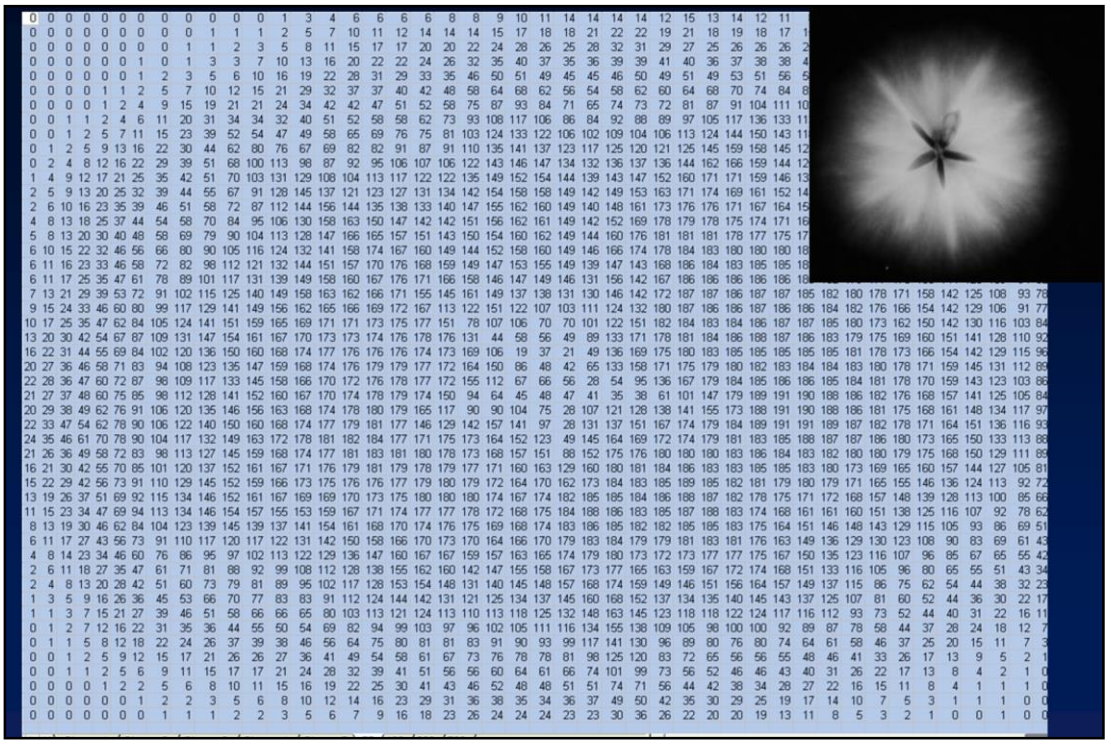
The average of a pixel may yet be considered to have infinite precision at this stage (the value of an analogous sign).



Quantization: avarages are rounded to a fixed set of numbers (such as integers)

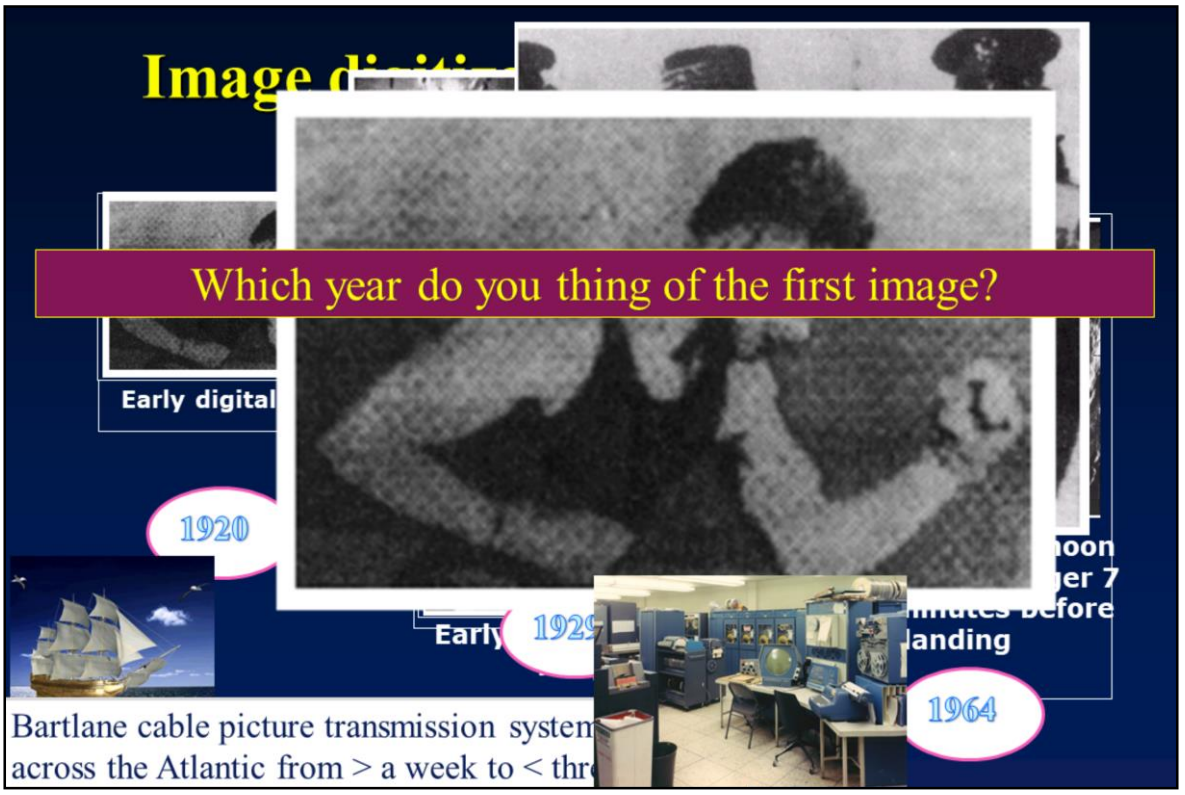


A digital image is discretized both in spatial coordinates and brightness.



It can be considered as a matrix whose row, column indices specitfy a point in the image and the element value identifies gray level value at that point. These elements are referred to as pixels.

X-ray image and digital value of an apple.

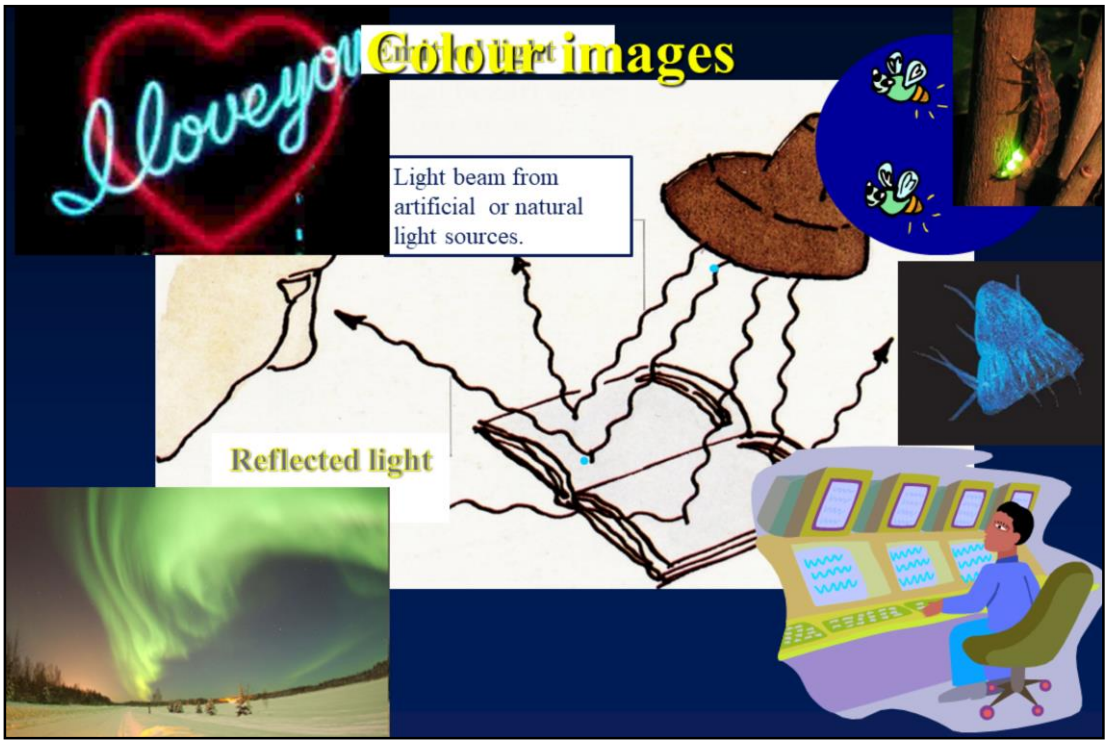


One of the first applications of digital images was digitized newspaper pictures sent by submarine cable between London and New York.

Bartlane cable picture transmission system in the early 1920's reduced the time required to transport a picture across the Atlantic from more than a week to less than three hours. The early Bartlane systems were capable of coding images in five distinct brightness levels.

This was increased to fifteen levels in 1929.
The combined advents of large-scale digital computers and the space program to bring into focus the potentials of digital image concepts. Work on using computer techniques for improving images from a space probe began at the Jet Propulsion Laboratory in 1964, when pictures of the Moon transmitted by Ranger 7 were processed by a computer to correct various types of image distortion inherent in the on-board television camera.

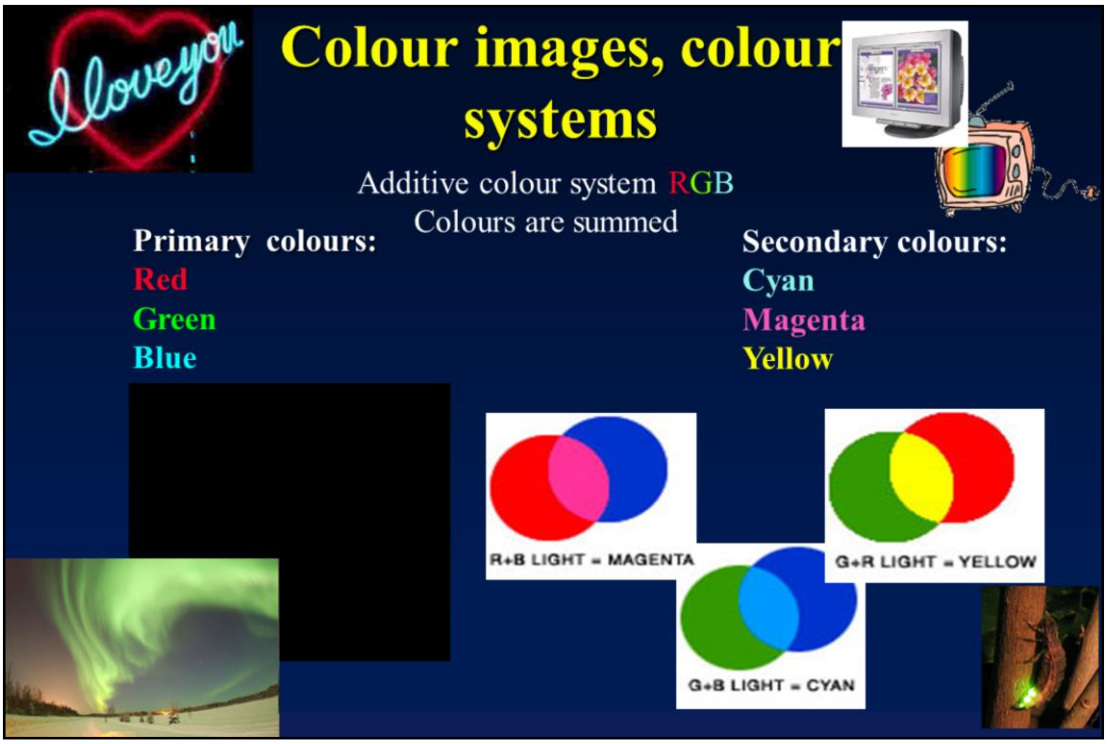
These techniques served as the basis for improved methods used in the enhancement and restoration of images from such familiar programs as the Surveyor missions to the Moon and the Mariner series of flyby missions to Mars.



Before discussing colours let us get clear that there are two ways to see objects:

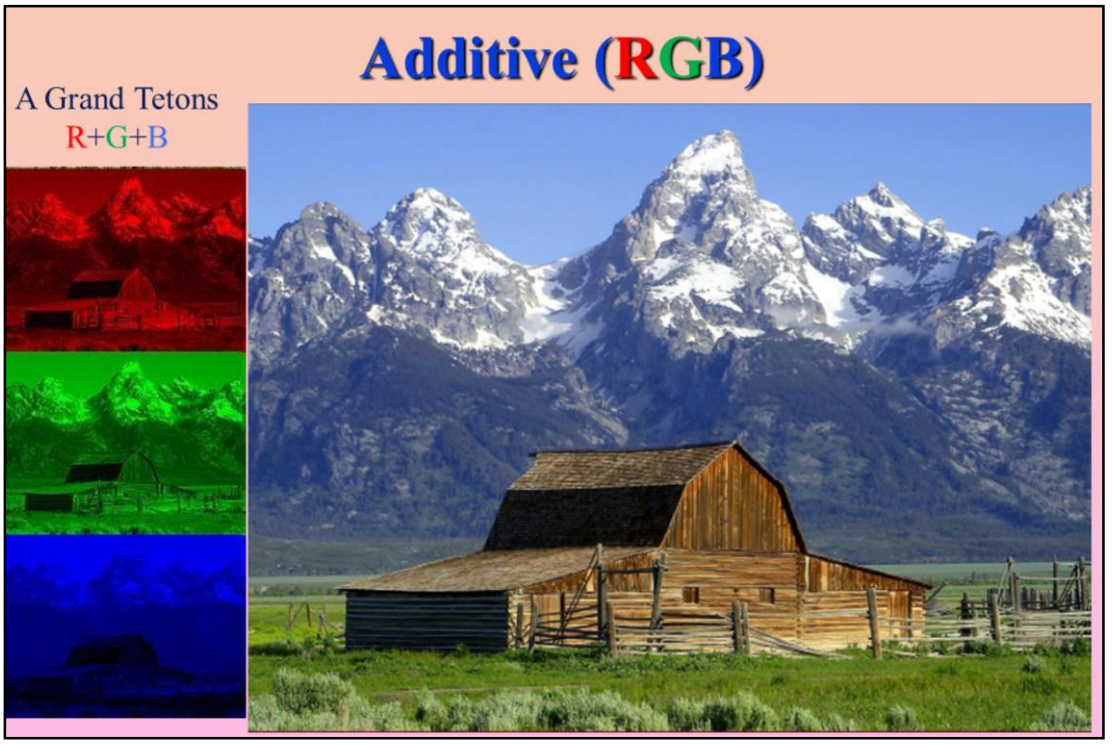
The object either reflects or emits light .

Neon light, bioluminescence, displays, aurora borealis (the northern lights) or aurora australis (the southern lights),



The additive colour is the mixing of various wavelength lights. The three primary colours: red, green, blue (RGB).

The white colour can be achived with the mixing of the three primary colours of identical intensity (the most complex light).

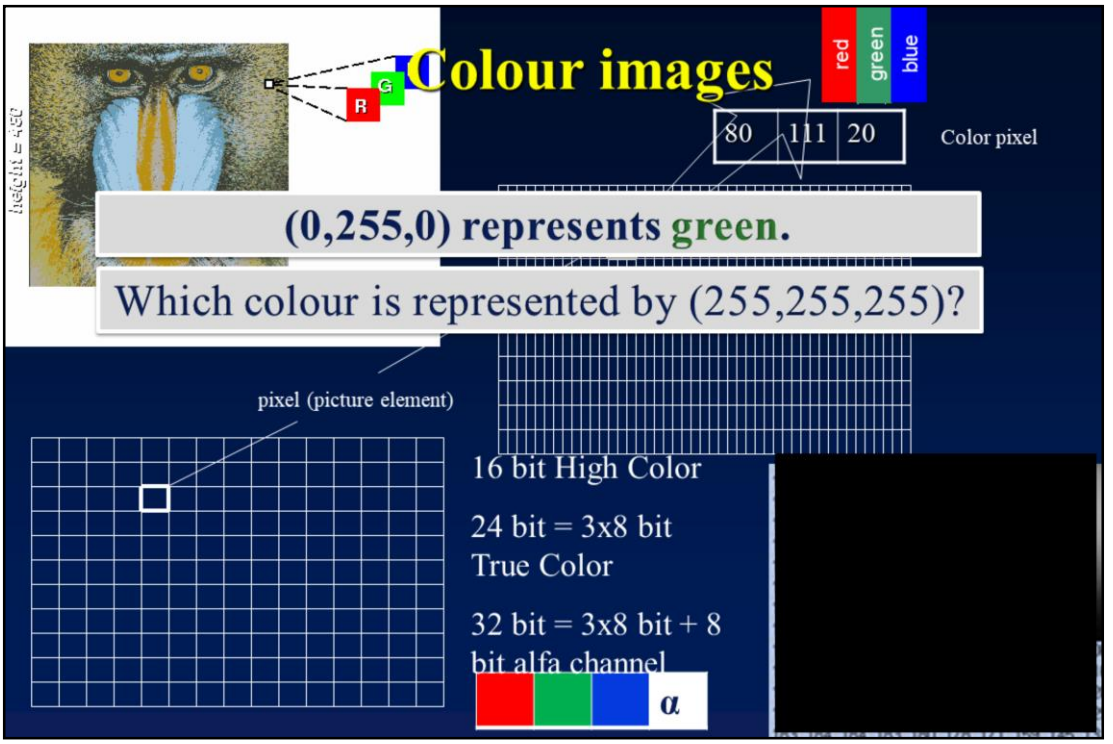


http://chemistry.beloit.edu/Stars/pages/colormix.html

With the mixing of the bundles of the single colour components with different intensity can be reached the various colours.

The white colour can be achived with the mixing of the three primary colours of identical intensity (the most complex light).

Colour image of Grand Tetons = R+G+B components



The computerised depiction of a color pixel. A pixel is divided into 3 bytes. The RGB components can be found in every byte. In the case of colored pictures the following color depths are typical:

8 bit, 256 colors

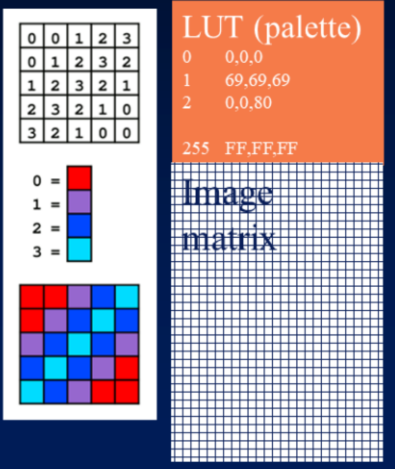
16 bit, more than 65.000 colors - **high color**

24 bit, more than 16 million colors - **true color**

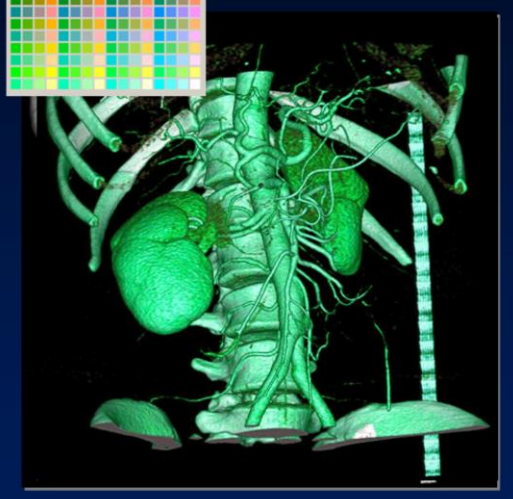
RGB colours. 8 bits 2 hexadecimal numbers.

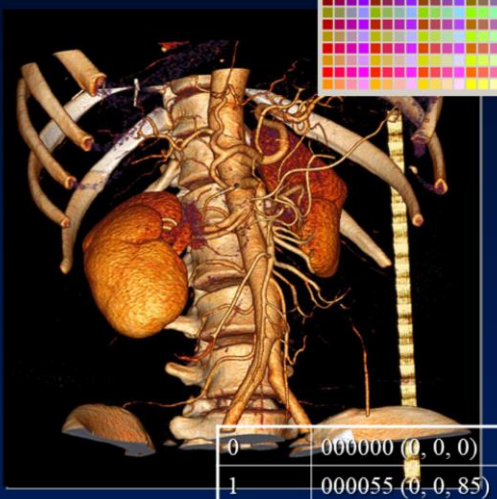
Indexed colour

A 2-bit indexed colour image.
The colour of each pixel is represented by a number; each number (the index) corresponds to a colour in the colour table (the palette).

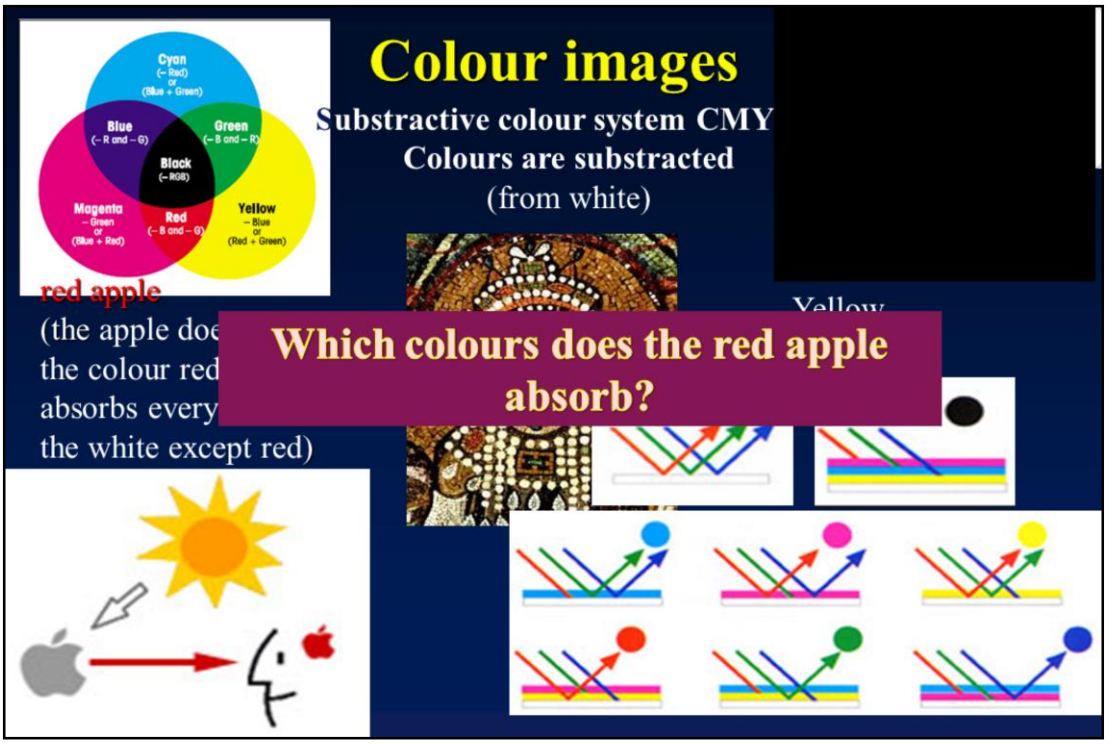


Look Up Table (LUT)





0	000000 (0, 0, 0)
1	000055 (0, 0, 85)
255	FFFFFF (255, 255,



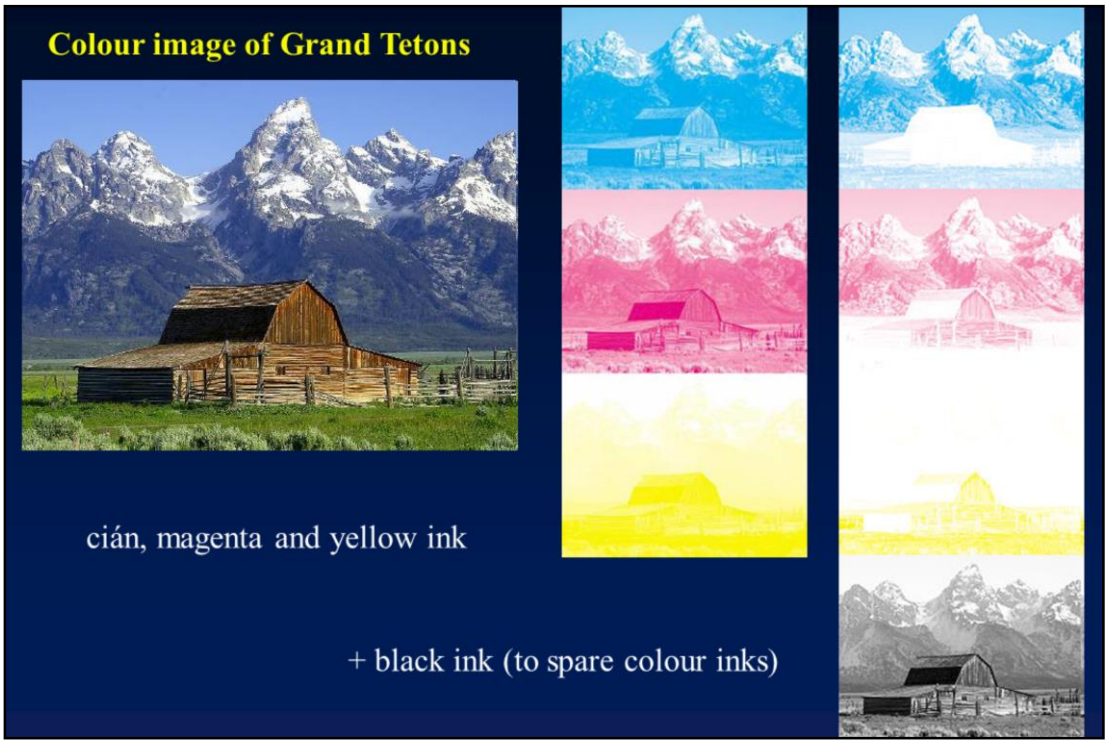
The subtractive colour system has the feature, that from the white light (implying all color shades) some are reflected, others are swallowed, subtracted.

The colour of the object is the mix of reflected colour.

The primary colours of this system are: **Cyan, Magenta, Yellow.**

In case of typographical applications dark colours stirring from the three primary colours is expensive and not clear, therefore black is used as a fourth colour.

The apple does not have a colour, does not radiate red light, it swallows everything from the white colour except red.



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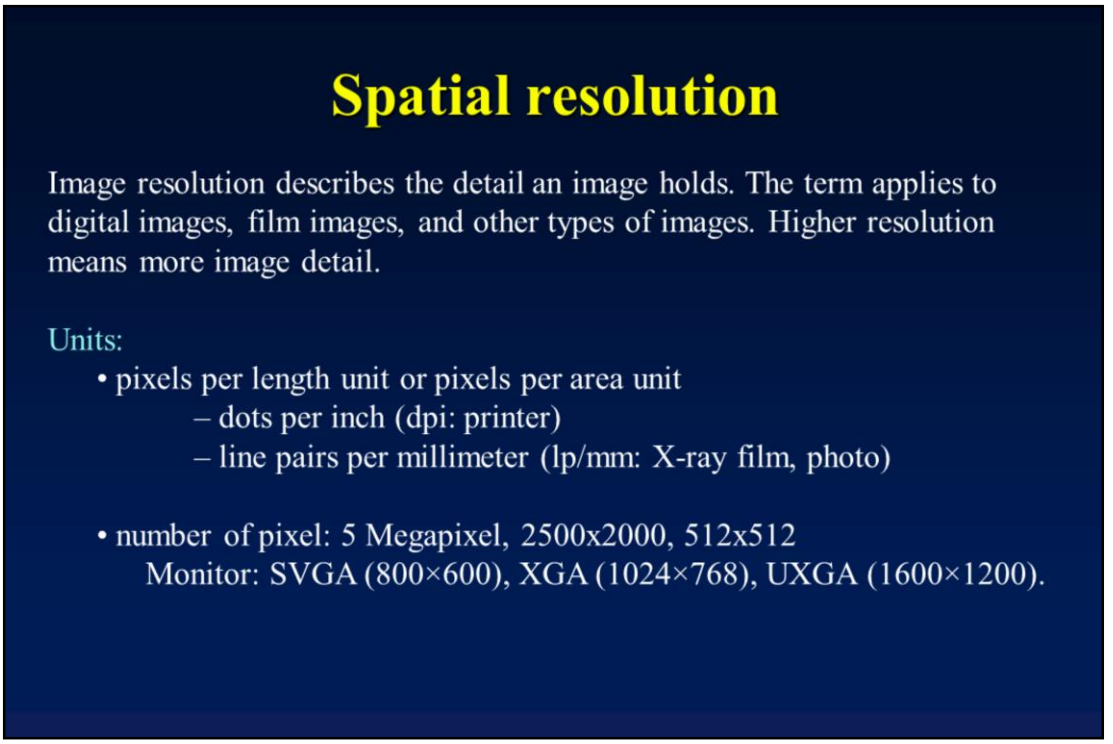
Propertis of digital images

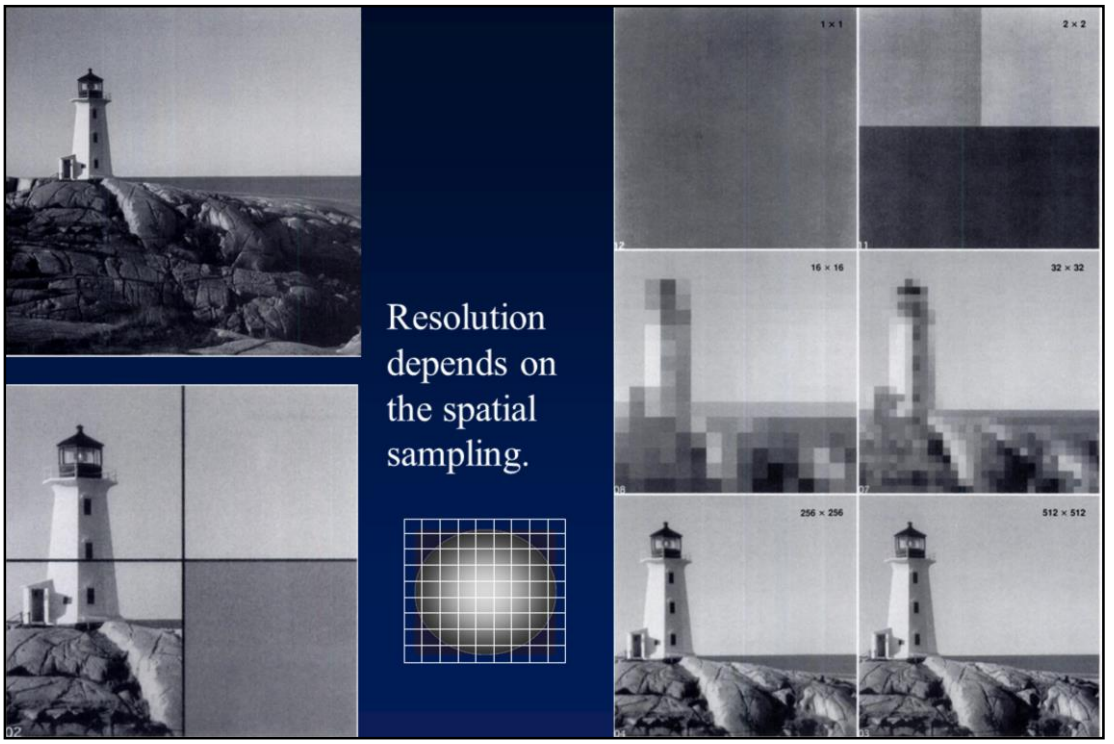
- Spatial resolution
- Pixel resolution



Spatial resolution describes **the ability of any image-forming device** such as an optical or radio telescope, a microscope, a camera, or an eye, **to distinguish small details of an object**.

Image resolution describes the detail an image holds. The term applies to digital images, film images, and other types of images. Higher resolution means more image detail.

But when the pixel counts are referred to as resolution, the convention is to describe the pixel resolution with the set of two positive integer numbers, where the first number is the number of pixel columns (width) and the second is the number of pixel rows (height), for example as 640 by 480. Another popular convention is to cite resolution as the total number of pixels in the image, typically given as number of megapixels, which can be calculated by multiplying pixel columns by pixel rows and dividing by one million. Other conventions include describing pixels per length unit or pixels per area unit, such as pixels per inch or per square inch.



Resolution depends on the spatial sampling (spatial discretization).

The digitization process begins by dividing the image into a number of regions called pixels (here, four), which are each filled with a single density. The lower right pixel is uniformly filled with the average density of the corresponding region of the original image.

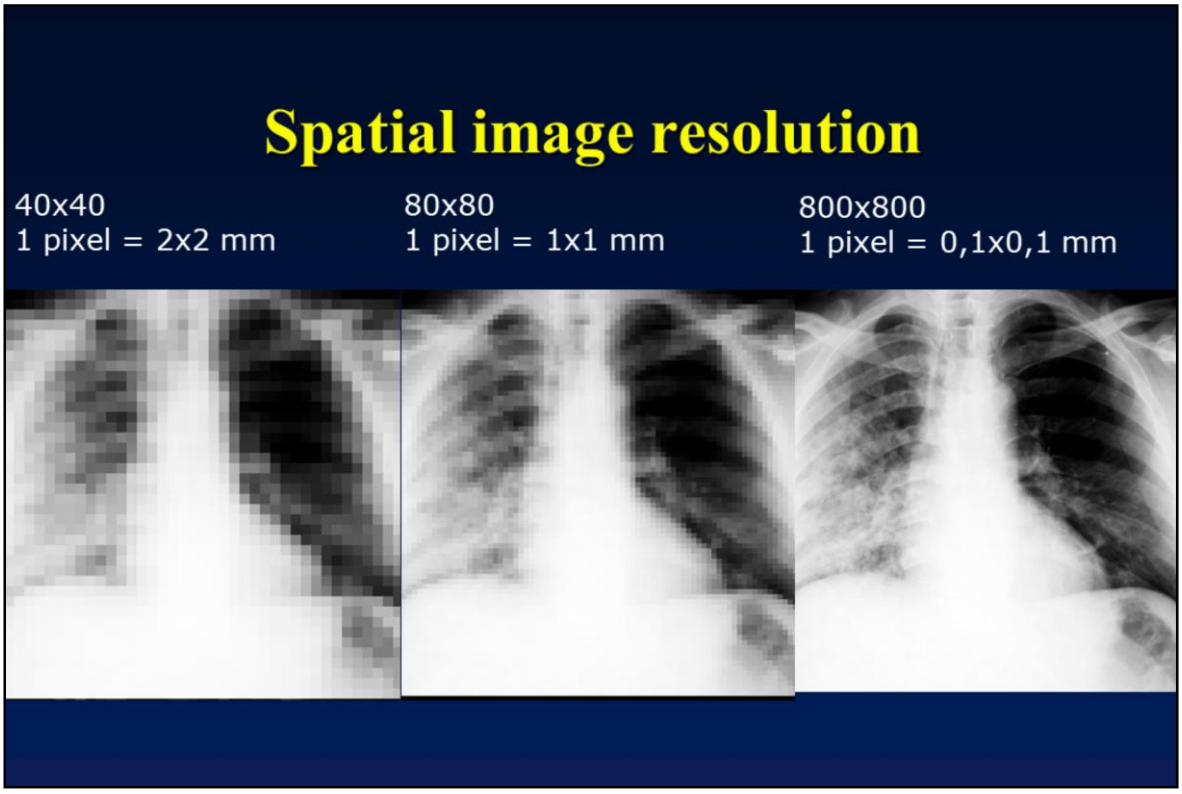
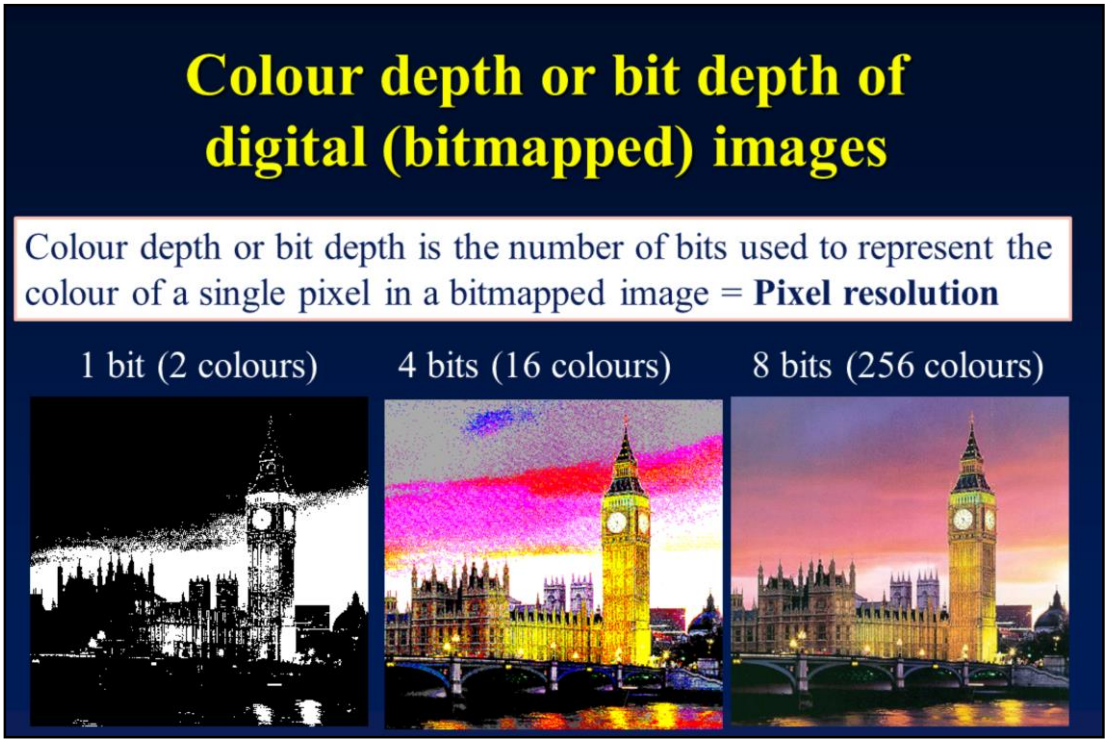


Image property: resolution

Scanned chest.

Eddig!!!!!!!!!!!!!!!!!!



Colour depth or bit depth is the number of bits used to represent the color of a single pixel in a bitmapped image

• 1 bit = 1+1 color (eg. Black and white).

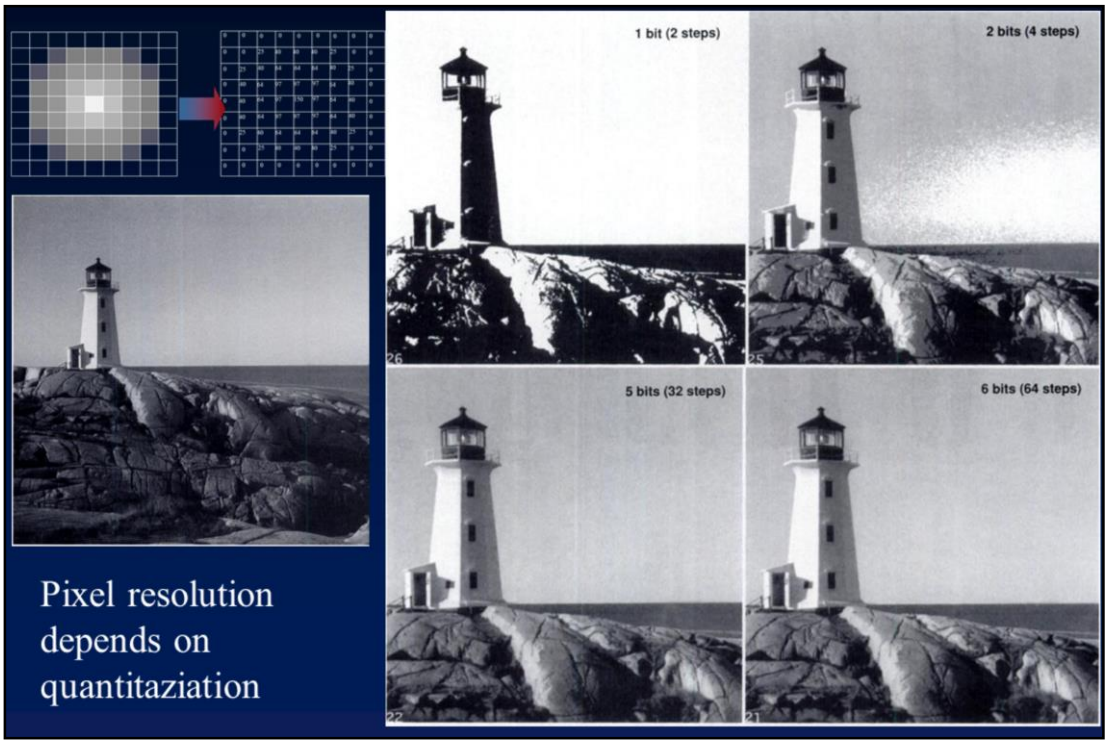
• 8 bit (1 byte) = 256 color- or shadow density.

• 3 x 8 bit (3 byte) = 3 color x 256 density= 16 million color. + 8 bit – alfa channel = 256 opacity.

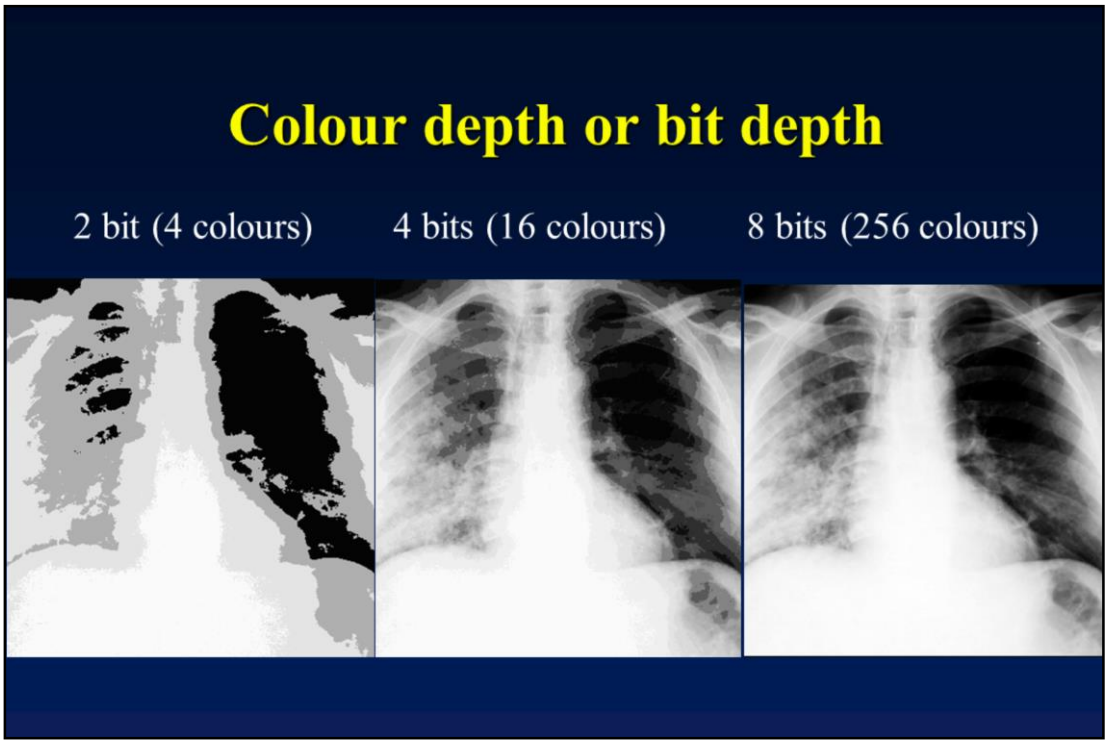
• 3 x 12 bit = 3 x 4096

Pixel resolution determines how finely a system can represent or distinguish differences of intensity, and is usually expressed as a number of levels or a number of bits, for example 8 bits or 256 levels that is typical of computer image files. The higher the radiometric resolution, the better subtle differences of intensity or reflectivity can be represented, at least in theory. In practice, the effective radiometric resolution is typically limited by the noise level, rather than by the number of bits of representation.

In computer graphics, color depth or bit depth is the number of bits used to represent the color of a single pixel in a bitmapped image or video frame buffer. This concept is also known as bits per pixel (bpp), particularly when specified along with the number of bits used. Higher color depth gives a broader range of distinct colors.



Images demonstrate the effect of bit depth on image quality. Use of too few steps causes the ‘clouds‘ seen in the 2-bit images. These are artifactual contours produced by insufficient bit depth.



2 bits, 4 bits, 8 bits

Related questions

- Information (definition, theory, bit)
- Image, digital image, pixel
- Digital image types
- Digitization, sampling, quantization
- Electromagnetic rays in imaging
- Colours, colour systems: RGB
- Properties of digital image (resolution, colour images, colour paletta, high colour, true colour)