KAPITAŁ LUDZKI
NARODOWA STRATEGIA SPÓJNOŚCI

UNIA EUROPEJSKA
EUROPEJSKI
FUNDUSZ SPOŁECZNY

„Image Processing and Computer Graphics”

Prezentacja multimedialna współfinansowana przez Unię Europejską w ramach Europejskiego Funduszu Społecznego w projekcie pt.

„Innowacyjna dydaktyka bez ograniczeń - zintegrowany rozwój Politechniki Łódzkiej - zarządzanie Uczelnią, nowoczesna oferta edukacyjna i wzmacniania zdolności do zatrudniania osób niepełnosprawnych”

Politechnika Łódzka

Contribution

Lecturer:

Piotr M. Szczypiński, Dr inż.
Institute of Electronics, Technical University of Lodz
Wolczanska 211/215, 90-924 Lodz, Poland
tel. +48426312638
http://www.eletel.p.lodz.pl/pms
pms@p.lodz.pl

Fragments of the lecture were also provided by

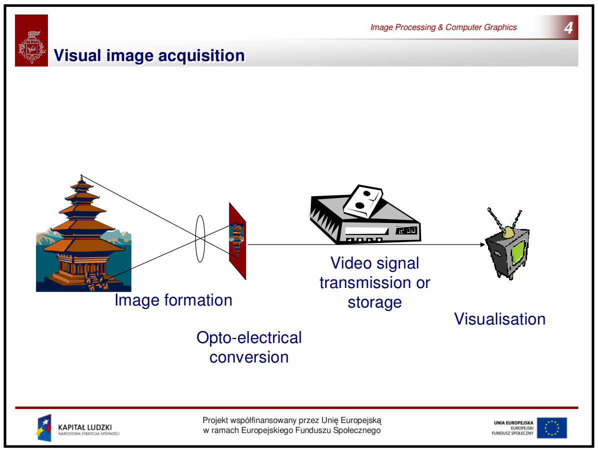
Andrzej Materka, Michał Strzelecki, Paweł Strumiłło, Piotr Romaniuk, Piotr Makowski

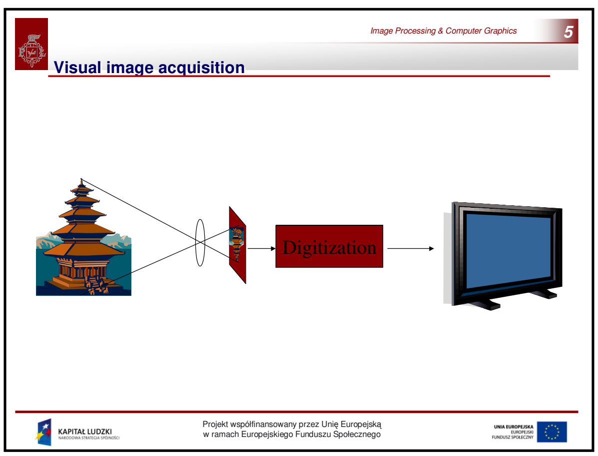
and were used with permission.

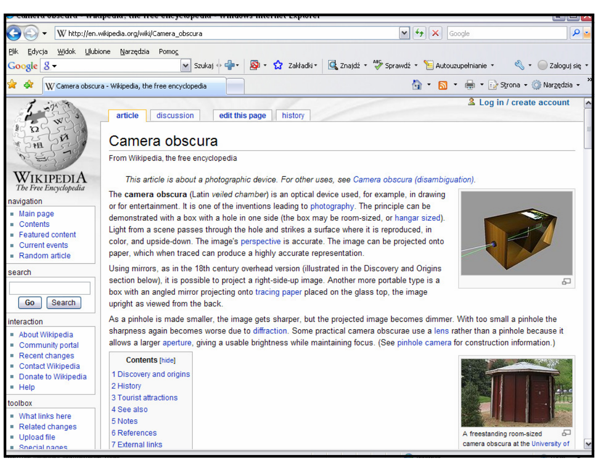
Portions of this lecture are illustrated with articles from the wikipedia
(GNU Free Documentation License
http://en.wikipedia.org/wiki/Wikipedia:Text_of_the_GNU_Free_Documentation_License)

Acquisition

Biomedical image acquisition
- Visual images
- Endoscopy (push and wireless)
- Confocal microscopy
- Tomography CT, MRI, PET
- USG, USG 3D
- Thermography
- Monochromatic image representation






http://en.wikipedia.org/wiki/Camera_obscura

Plik Edycja Widok Ulubione Narzędzia Pomoc

Camera obscura - Wikipedia, the free encyclopedia

Log in / create account

article | discussion | edit this page | history

WIKIPEDIA
The Free Encyclopedia

navigation
- Main page
- Contents
- Featured content
- Current events
- Random article

search
Go | Search

interaction
- About Wikipedia
- Community portal
- Recent changes
- Contact Wikipedia
- Donate to Wikipedia
- Help

toolbox
- What links here
- Related changes
- Upload file
- Special pages

Camera obscura

From Wikipedia, the free encyclopedia

This article is about a photographic device. For other uses, see Camera obscura (disambiguation).

The **camera obscura** (Latin *veiled chamber*) is an optical device used, for example, in drawing or for entertainment. It is one of the inventions leading to photography. The principle can be demonstrated with a box with a hole in one side (the box may be room-sized, or hangar sized). Light from a scene passes through the hole and strikes a surface where it is reproduced, in color, and upside-down. The image's perspective is accurate. The image can be projected onto paper, which when traced can produce a highly accurate representation.

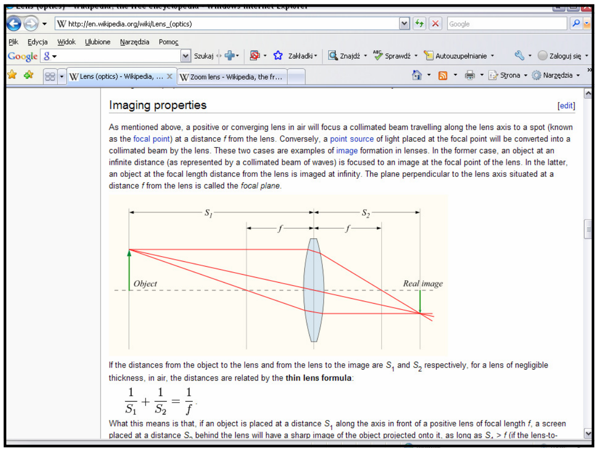
Using mirrors, as in the 18th century overhead version (illustrated in the Discovery and Origins section below), it is possible to project a right-side-up image. Another more portable type is a box with an angled mirror projecting onto tracing paper placed on the glass top, the image upright as viewed from the back.

As a pinhole is made smaller, the image gets sharper, but the projected image becomes dimmer. With too small a pinhole the sharpness again becomes worse due to diffraction. Some practical camera obscurae use a lens rather than a pinhole because it allows a larger aperture, giving a usable brightness while maintaining focus. (See pinhole camera for construction information.)

Contents [hide]

1 Discovery and origins
2 History
3 Tourist attractions
4 See also
5 Notes
6 References
7 External links

A freestanding room-sized camera obscura at the University of


http://en.wikipedia.org/wiki/Lens_(optics)

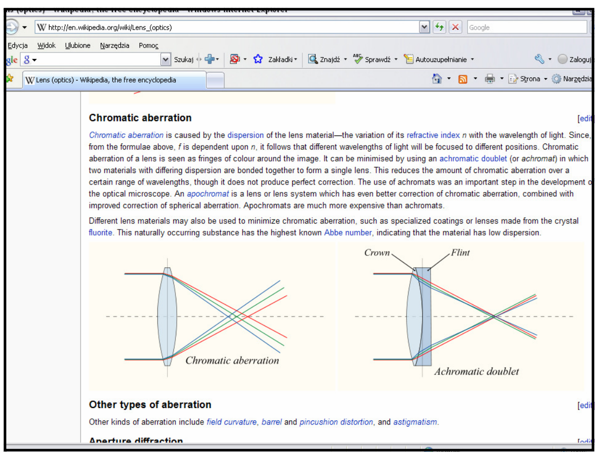
Imaging properties

As mentioned above, a positive or converging lens in air will focus a collimated beam travelling along the lens axis to a spot (known as the focal point) at a distance *f* from the lens. Conversely, a point source of light placed at the focal point will be converted into a collimated beam by the lens. These two cases are examples of image formation in lenses. In the former case, an object at an infinite distance (as represented by a collimated beam of waves) is focused to an image at the focal point of the lens. In the latter, an object at the focal length distance from the lens is imaged at infinity. The plane perpendicular to the lens axis situated at a distance *f* from the lens is called the *focal plane*.

If the distances from the object to the lens and from the lens to the image are S_1 and S_2 respectively, for a lens of negligible thickness, in air, the distances are related by the **thin lens formula**:

$$\frac{1}{S_1} + \frac{1}{S_2} = \frac{1}{f}.$$

What this means is that, if an object is placed at a distance S_1 along the axis in front of a positive lens of focal length *f*, a screen placed at a distance S_2 behind the lens will have a sharp image of the object projected onto it, as long as $S_1 > f$ (if the lens-to-


http://en.wikipedia.org/wiki/Lens_(optics)

Chromatic aberration

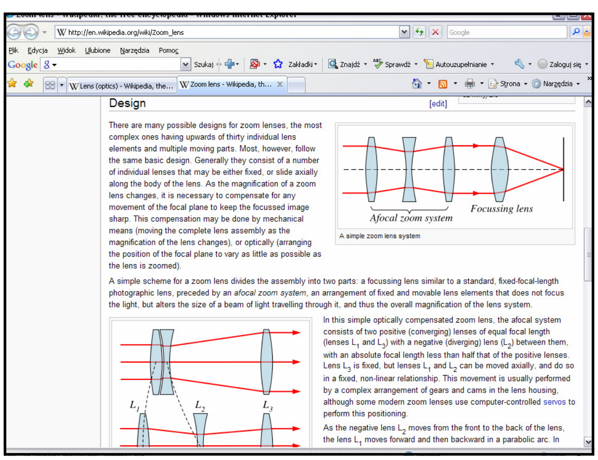
Chromatic aberration is caused by the dispersion of the lens material—the variation of its refractive index *n* with the wavelength of light. Since, from the formulae above, *f* is dependent upon *n*, it follows that different wavelengths of light will be focused to different positions. Chromatic aberration of a lens is seen as fringes of colour around the image. It can be minimised by using an achromatic doublet (or *achromat*) in which two materials with differing dispersion are bonded together to form a single lens. This reduces the amount of chromatic aberration over a certain range of wavelengths, though it does not produce perfect correction. The use of achromats was an important step in the development of the optical microscope. An *apochromat* is a lens or lens system which has even better correction of chromatic aberration, combined with improved correction of spherical aberration. Apochromats are much more expensive than achromats.

Different lens materials may also be used to minimize chromatic aberration, such as specialized coatings or lenses made from the crystal fluorite. This naturally occurring substance has the highest known Abbe number, indicating that the material has low dispersion.

Other types of aberration

Other kinds of aberration include *field curvature*, *barrel* and *pincushion distortion*, and *astigmatism*.

Aperture diffraction


http://en.wikipedia.org/wiki/Zoom_lens

Design

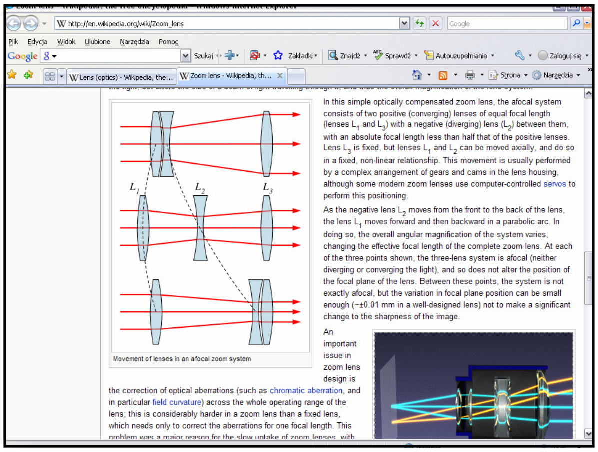
There are many possible designs for zoom lenses, the most complex ones having upwards of thirty individual lens elements and multiple moving parts. Most, however, follow the same basic design. Generally they consist of a number of individual lenses that may be either fixed, or slide axially along the body of the lens. As the magnification of a zoom lens changes, it is necessary to compensate for any movement of the focal plane to keep the focussed image sharp. This compensation may be done by mechanical means (moving the complete lens assembly as the magnification of the lens changes), or optically (arranging the position of the focal plane to vary as little as possible as the lens is zoomed).

A simple zoom lens system

A simple scheme for a zoom lens divides the assembly into two parts: a focussing lens similar to a standard, fixed-focal-length photographic lens, preceded by an *afocal zoom system*, an arrangement of fixed and movable lens elements that does not focus the light, but alters the size of a beam of light travelling through it, and thus the overall magnification of the lens system.

In this simple optically compensated zoom lens, the afocal system consists of two positive (converging) lenses of equal focal length (lenses L_1 and L_3) with a negative (diverging) lens (L_2) between them, with an absolute focal length less than half that of the positive lenses. Lens L_3 is fixed, but lenses L_1 and L_2 can be moved axially, and do so in a fixed, non-linear relationship. This movement is usually performed by a complex arrangement of gears and cams in the lens housing, although some modern zoom lenses use computer-controlled servos to perform this positioning.

As the negative lens L_2 moves from the front to the back of the lens, the lens L_1 moves forward and then backward in a parabolic arc. In

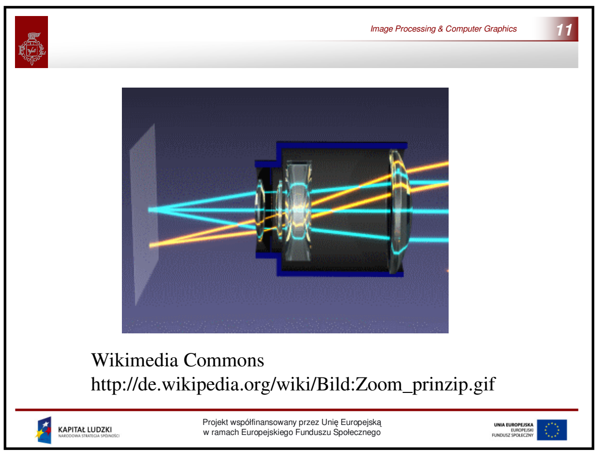


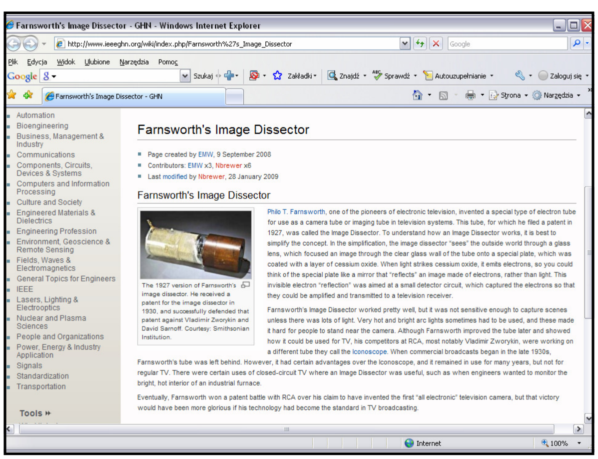
In this simple optically compensated zoom lens, the afocal system consists of two positive (converging) lenses of equal focal length (lenses L_1 and L_3) with a negative (diverging) lens (L_2) between them, with an absolute focal length less than half that of the positive lenses. Lens L_3 is fixed, but lenses L_1 and L_2 can be moved axially, and do so in a fixed, non-linear relationship. This movement is usually performed by a complex arrangement of gears and cams in the lens housing, although some modern zoom lenses use computer-controlled servos to perform this positioning.

As the negative lens L_2 moves from the front to the back of the lens, the lens L_1 moves forward and then backward in a parabolic arc. In doing so, the overall angular magnification of the system varies, changing the effective focal length of the complete zoom lens. At each of the three points shown, the three-lens system is afocal (neither diverging or converging the light), and so does not alter the position of the focal plane of the lens. Between these points, the system is not exactly afocal, but the variation in focal plane position can be small enough (~±0.01 mm in a well-designed lens) not to make a significant change to the sharpness of the image.

Movement of lenses in an afocal zoom system

An important issue in zoom lens design is the correction of optical aberrations (such as chromatic aberration, and in particular field curvature) across the whole operating range of the lens; this is considerably harder in a zoom lens than a fixed lens, which needs only to correct the aberrations for one focal length. This





Farnsworth's Image Dissector

- Page created by EMW, 9 September 2008
- Contributors: EMW x3, Nbrewer x6
- Last modified by Nbrewer, 28 January 2009

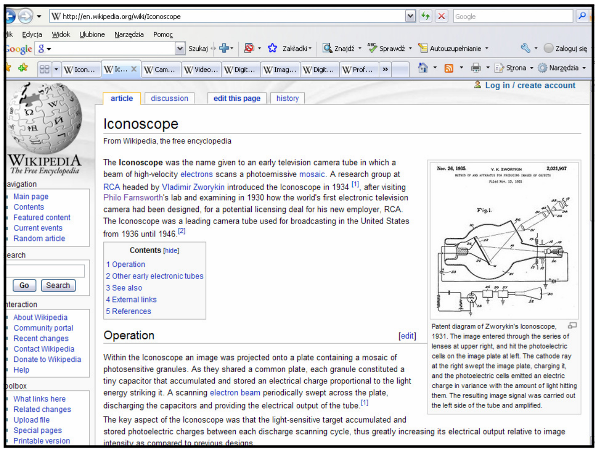
Farnsworth's Image Dissector

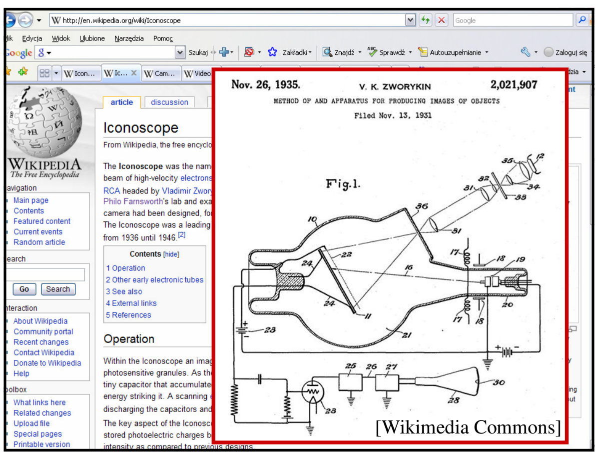
The 1927 version of Farnsworth's image dissector. He received a patent for the image dissector in 1930, and successfully defended that patent against Vladimir Zworykin and David Sarnoff. Courtesy: Smithsonian Institution.

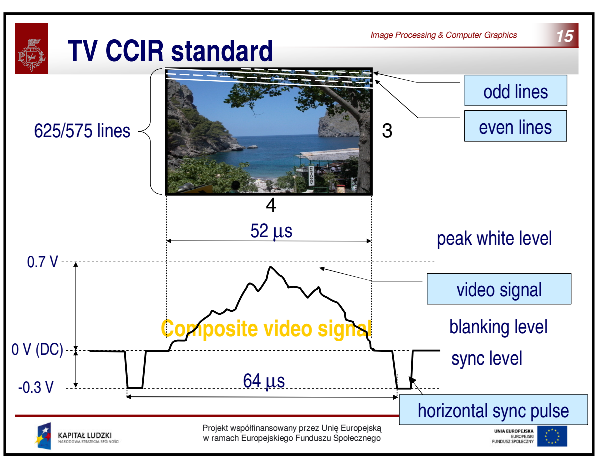
Philo T. Farnsworth, one of the pioneers of electronic television, invented a special type of electron tube for use as a camera tube or imaging tube in television systems. This tube, for which he filed a patent in 1927, was called the Image Dissector. To understand how an Image Dissector works, it is best to simplify the concept. In the simplification, the image dissector "sees" the outside world through a glass lens, which focused an image through the clear glass wall of the tube onto a special plate, which was coated with a layer of cessium oxide. When light strikes cessium oxide, it emits electrons, so you could think of the special plate like a mirror that "reflects" an image made of electrons, rather than light. This invisible electron "reflection" was aimed at a small detector circuit, which captured the electrons so that they could be amplified and transmitted to a television receiver.

Farnsworth's Image Dissector worked pretty well, but it was not sensitive enough to capture scenes unless there was lots of light. Very hot and bright arc lights sometimes had to be used, and these made it hard for people to stand near the camera. Although Farnsworth improved the tube later and showed how it could be used for TV, his competitors at RCA, most notably Vladimir Zworykin, were working on a different tube they call the Iconoscope. When commercial broadcasts began in the late 1930s, Farnsworth's tube was left behind. However, it had certain advantages over the Iconoscope, and it remained in use for many years, but not for regular TV. There were certain uses of closed-circuit TV where an Image Dissector was useful, such as when engineers wanted to monitor the bright, hot interior of an industrial furnace.

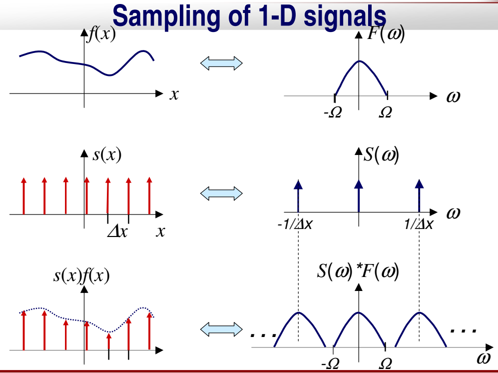
Eventually, Farnsworth won a patent battle with RCA over his claim to have invented the first "all electronic" television camera, but that victory would have been more glorious if his technology had become the standard in TV broadcasting.


http://en.wikipedia.org/wiki/Iconoscope
article
discussion
edit this page
history
Log in / create account
WIKIPEDIA
The Free Encyclopedia
Iconoscope
From Wikipedia, the free encyclopedia
The Iconoscope was the name given to an early television camera tube in which a beam of high-velocity electrons scans a photoemissive mosaic. A research group at RCA headed by Vladimir Zworykin introduced the Iconoscope in 1934 [1], after visiting Philo Farnsworth's lab and examining in 1930 how the world's first electronic television camera had been designed, for a potential licensing deal for his new employer, RCA. The Iconoscope was a leading camera tube used for broadcasting in the United States from 1936 until 1946.[2]
Contents [hide]
1 Operation
2 Other early electronic tubes
3 See also
4 External links
5 References
Operation
[edit]
Within the Iconoscope an image was projected onto a plate containing a mosaic of photosensitive granules. As they shared a common plate, each granule constituted a tiny capacitor that accumulated and stored an electrical charge proportional to the light energy striking it. A scanning electron beam periodically swept across the plate, discharging the capacitors and providing the electrical output of the tube.[1]
The key aspect of the Iconoscope was that the light-sensitive target accumulated and stored photoelectric charges between each discharge scanning cycle, thus greatly increasing its electrical output relative to image intensity as compared to previous designs.
Patent diagram of Zworykin's Iconoscope, 1931. The image entered through the series of lenses at upper right, and hit the photoelectric cells on the image plate at left. The cathode ray at the right swept the image plate, charging it, and the photoelectric cells emitted an electric charge in variance with the amount of light hitting them. The resulting image signal was carried out the left side of the tube and amplified.


Nov. 26, 1935.
V. K. ZWORYKIN
2,021,907
METHOD OF AND APPARATUS FOR PRODUCING IMAGES OF OBJECTS
Filed Nov. 13, 1931
Fig.1.
[Wikimedia Commons]


TV CCIR standard
Image Processing & Computer Graphics
15
odd lines
even lines
625/575 lines
3
4
52 µs
peak white level
0.7 V
video signal
Composite video signal
blanking level
0 V (DC)
sync level
64 µs
-0.3 V
horizontal sync pulse
KAPITAŁ LUDZKI
Projekt współfinansowany przez Unię Europejską
w ramach Europejskiego Funduszu Społecznego
UNIA EUROPEJSKA
EUROPEJSKI FUNDUSZ SPOŁECZNY

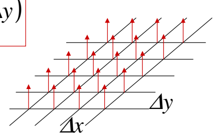
Sampling of 1-D signals



Sampling of 2-D signals

Image sampling function:

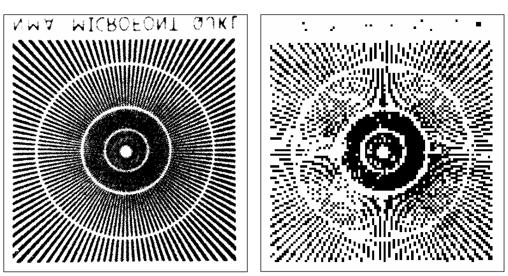
$$S(x,y)=\sum_{i=0}^{M-1}\sum_{k=0}^{N-1}\delta(x-i\Delta x,\, y-k\Delta y)$$



and a sampled image:

$$f_s(x,y)=f(x,y)S(x,y)=$$
$$=\sum_{i=0}^{M-1}\sum_{k=0}^{N-1} f(i\Delta x, k\Delta y)\,\delta(x-i\Delta x,\, y-k\Delta y)$$

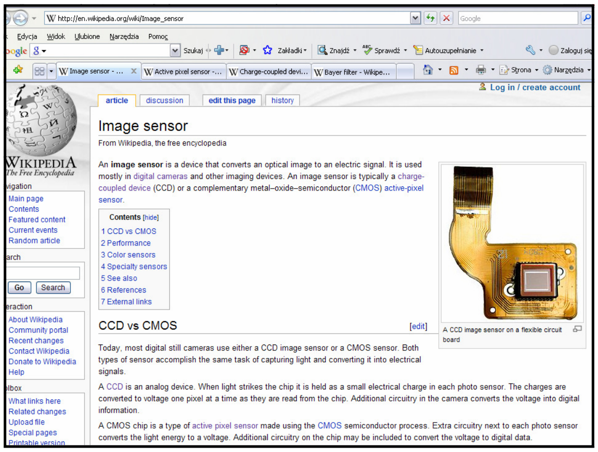
Aliasing distortion - example



Scanned images:

500 dpi

100 dpi
(dots per inch)



http://en.wikipedia.org/wiki/Image_sensor

Image sensor

From Wikipedia, the free encyclopedia

An **image sensor** is a device that converts an optical image to an electric signal. It is used mostly in digital cameras and other imaging devices. An image sensor is typically a charge-coupled device (CCD) or a complementary metal–oxide–semiconductor (CMOS) active-pixel sensor.

Contents [hide]

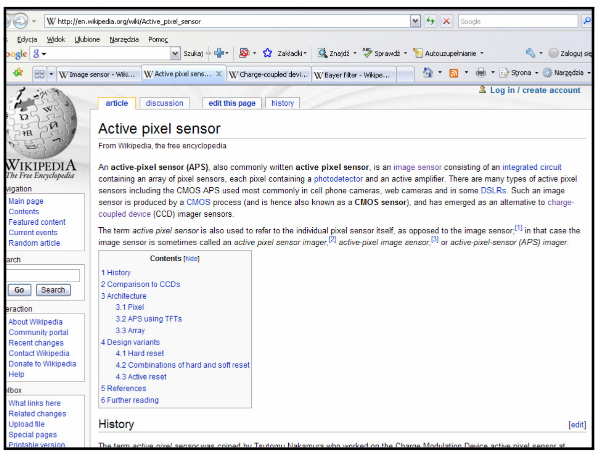
A CCD image sensor on a flexible circuit board

CCD vs CMOS [edit]

Today, most digital still cameras use either a CCD image sensor or a CMOS sensor. Both types of sensor accomplish the same task of capturing light and converting it into electrical signals.

A CCD is an analog device. When light strikes the chip it is held as a small electrical charge in each photo sensor. The charges are converted to voltage one pixel at a time as they are read from the chip. Additional circuitry in the camera converts the voltage into digital information.

A CMOS chip is a type of active pixel sensor made using the CMOS semiconductor process. Extra circuitry next to each photo sensor converts the light energy to a voltage. Additional circuitry on the chip may be included to convert the voltage to digital data.



http://en.wikipedia.org/wiki/Active_pixel_sensor

Active pixel sensor

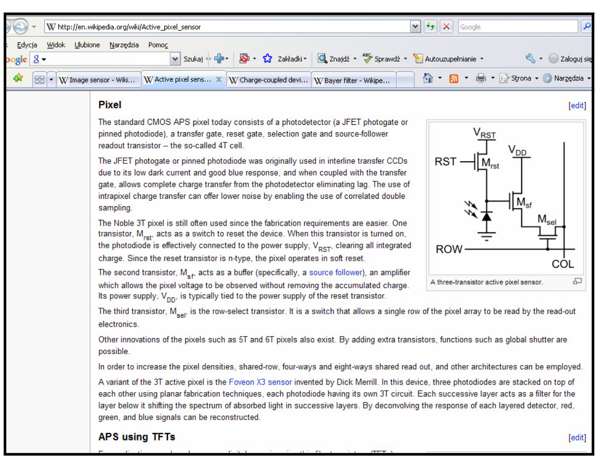
From Wikipedia, the free encyclopedia

An **active-pixel sensor (APS)**, also commonly written **active pixel sensor**, is an image sensor consisting of an integrated circuit containing an array of pixel sensors, each pixel containing a photodetector and an active amplifier. There are many types of active pixel sensors including the CMOS APS used most commonly in cell phone cameras, web cameras and in some DSLRs. Such an image sensor is produced by a CMOS process (and is hence also known as a **CMOS sensor**), and has emerged as an alternative to charge-coupled device (CCD) imager sensors.

The term *active pixel sensor* is also used to refer to the individual pixel sensor itself, as opposed to the image sensor;[1] in that case the image sensor is sometimes called an *active pixel sensor imager*,[2] *active-pixel image sensor*,[3] or *active-pixel-sensor (APS) imager*.

Contents [hide]

History [edit]



http://en.wikipedia.org/wiki/Active_pixel_sensor

Pixel [edit]

The standard CMOS APS pixel today consists of a photodetector (a JFET photogate or pinned photodiode), a transfer gate, reset gate, selection gate and source-follower readout transistor -- the so-called 4T cell.

The JFET photogate or pinned photodiode was originally used in interline transfer CCDs due to its low dark current and good blue response, and when coupled with the transfer gate, allows complete charge transfer from the photodetector eliminating lag. The use of intrapixel charge transfer can offer lower noise by enabling the use of correlated double sampling.

The Noble 3T pixel is still often used since the fabrication requirements are easier. One transistor, M_{rst}, acts as a switch to reset the device. When this transistor is turned on, the photodiode is effectively connected to the power supply, V_{RST}, clearing all integrated charge. Since the reset transistor is n-type, the pixel operates in soft reset.

The second transistor, M_{sf}, acts as a buffer (specifically, a source follower), an amplifier which allows the pixel voltage to be observed without removing the accumulated charge. Its power supply, V_{DD}, is typically tied to the power supply of the reset transistor.

The third transistor, M_{sel}, is the row-select transistor. It is a switch that allows a single row of the pixel array to be read by the read-out electronics.

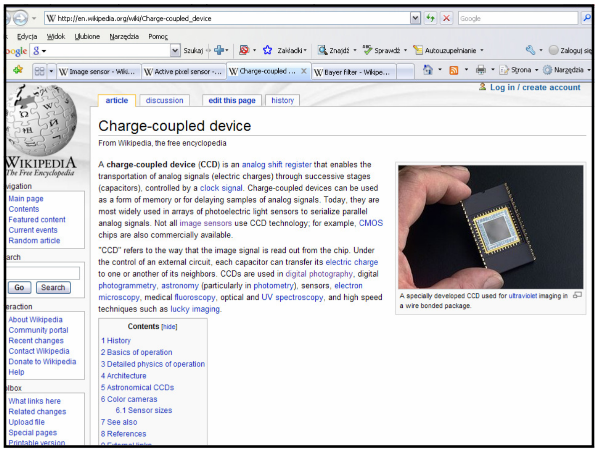
Other innovations of the pixels such as 5T and 6T pixels also exist. By adding extra transistors, functions such as global shutter are possible.

In order to increase the pixel densities, shared-row, four-ways and eight-ways shared read out, and other architectures can be employed.

A variant of the 3T active pixel is the Foveon X3 sensor invented by Dick Merrill. In this device, three photodiodes are stacked on top of each other using planar fabrication techniques, each photodiode having its own 3T circuit. Each successive layer acts as a filter for the layer below it shifting the spectrum of absorbed light in successive layers. By deconvolving the response of each layered detector, red, green, and blue signals can be reconstructed.

A three-transistor active pixel sensor.

APS using TFTs [edit]


Charge-coupled device
From Wikipedia, the free encyclopedia
A charge-coupled device (CCD) is an analog shift register that enables the transportation of analog signals (electric charges) through successive stages (capacitors), controlled by a clock signal. Charge-coupled devices can be used as a form of memory or for delaying samples of analog signals. Today, they are most widely used in arrays of photoelectric light sensors to serialize parallel analog signals. Not all image sensors use CCD technology; for example, CMOS chips are also commercially available.
"CCD" refers to the way that the image signal is read out from the chip. Under the control of an external circuit, each capacitor can transfer its electric charge to one or another of its neighbors. CCDs are used in digital photography, digital photogrammetry, astronomy (particularly in photometry), sensors, electron microscopy, medical fluoroscopy, optical and UV spectroscopy, and high speed techniques such as lucky imaging.
A specially developed CCD used for ultraviolet imaging in a wire bonded package.
Contents
1 History
2 Basics of operation
3 Detailed physics of operation
4 Architecture
5 Astronomical CCDs
6 Color cameras
6.1 Sensor sizes
7 See also
8 References

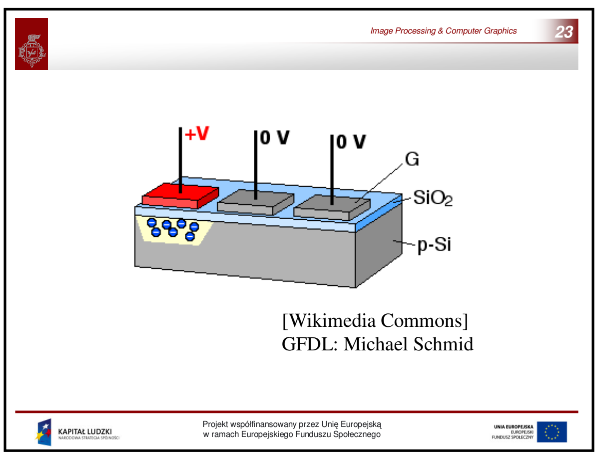
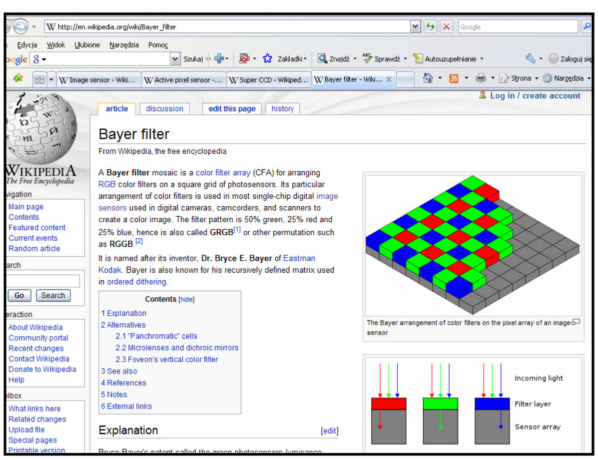
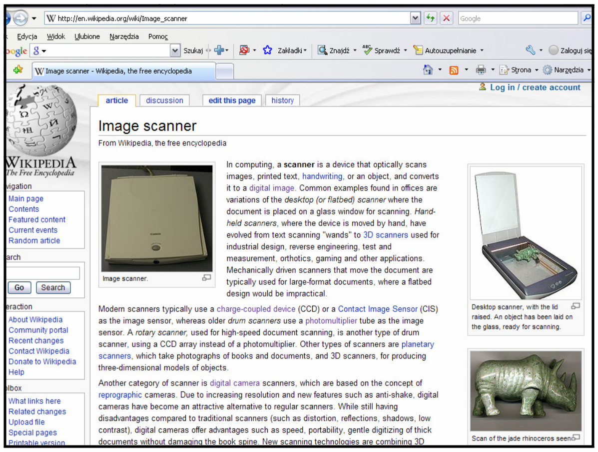


Image Processing & Computer Graphics
23
+V
0 V
0 V
G
SiO2
p-Si
[Wikimedia Commons]
GFDL: Michael Schmid
KAPITAŁ LUDZKI
Projekt współfinansowany przez Unię Europejską
w ramach Europejskiego Funduszu Społecznego


Bayer filter
From Wikipedia, the free encyclopedia
A Bayer filter mosaic is a color filter array (CFA) for arranging RGB color filters on a square grid of photosensors. Its particular arrangement of color filters is used in most single-chip digital image sensors used in digital cameras, camcorders, and scanners to create a color image. The filter pattern is 50% green, 25% red and 25% blue, hence is also called GRGB[1] or other permutation such as RGGB.[2]
It is named after its inventor, Dr. Bryce E. Bayer of Eastman Kodak. Bayer is also known for his recursively defined matrix used in ordered dithering.
Contents
1 Explanation
2 Alternatives
2.1 "Panchromatic" cells
2.2 Microlenses and dichroic mirrors
2.3 Foveon's vertical color filter
3 See also
4 References
5 Notes
6 External links
Explanation
The Bayer arrangement of color filters on the pixel array of an image sensor
Incoming light
Filter layer
Sensor array



http://en.wikipedia.org/wiki/Image_scanner

Image scanner - Wikipedia, the free encyclopedia

article | discussion | edit this page | history

Log in / create account

Image scanner

From Wikipedia, the free encyclopedia

In computing, a **scanner** is a device that optically scans images, printed text, handwriting, or an object, and converts it to a digital image. Common examples found in offices are variations of the *desktop (or flatbed) scanner* where the document is placed on a glass window for scanning. *Hand-held scanners*, where the device is moved by hand, have evolved from text scanning "wands" to 3D scanners used for industrial design, reverse engineering, test and measurement, orthotics, gaming and other applications. Mechanically driven scanners that move the document are typically used for large-format documents, where a flatbed design would be impractical.

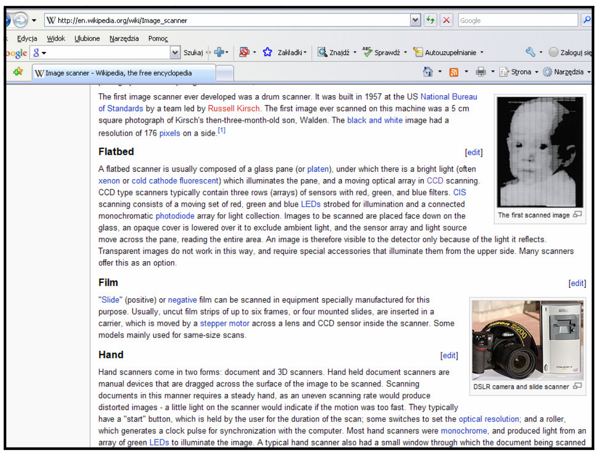
Image scanner.

Desktop scanner, with the lid raised. An object has been laid on the glass, ready for scanning.

Modern scanners typically use a charge-coupled device (CCD) or a Contact Image Sensor (CIS) as the image sensor, whereas older *drum scanners* use a photomultiplier tube as the image sensor. A *rotary scanner,* used for high-speed document scanning, is another type of drum scanner, using a CCD array instead of a photomultiplier. Other types of scanners are planetary scanners, which take photographs of books and documents, and 3D scanners, for producing three-dimensional models of objects.

Another category of scanner is digital camera scanners, which are based on the concept of reprographic cameras. Due to increasing resolution and new features such as anti-shake, digital cameras have become an attractive alternative to regular scanners. While still having disadvantages compared to traditional scanners (such as distortion, reflections, shadows, low contrast), digital cameras offer advantages such as speed, portability, gentle digitizing of thick documents without damaging the book spine. New scanning technologies are combining 3D

Scan of the jade rhinoceros seen



http://en.wikipedia.org/wiki/Image_scanner

Image scanner - Wikipedia, the free encyclopedia

The first image scanner ever developed was a drum scanner. It was built in 1957 at the US National Bureau of Standards by a team led by Russell Kirsch. The first image ever scanned on this machine was a 5 cm square photograph of Kirsch's then-three-month-old son, Walden. The black and white image had a resolution of 176 pixels on a side.[1]

The first scanned image

Flatbed [edit]

A flatbed scanner is usually composed of a glass pane (or platen), under which there is a bright light (often xenon or cold cathode fluorescent) which illuminates the pane, and a moving optical array in CCD scanning. CCD type scanners typically contain three rows (arrays) of sensors with red, green, and blue filters. CIS scanning consists of a moving set of red, green and blue LEDs strobed for illumination and a connected monochromatic photodiode array for light collection. Images to be scanned are placed face down on the glass, an opaque cover is lowered over it to exclude ambient light, and the sensor array and light source move across the pane, reading the entire area. An image is therefore visible to the detector only because of the light it reflects. Transparent images do not work in this way, and require special accessories that illuminate them from the upper side. Many scanners offer this as an option.

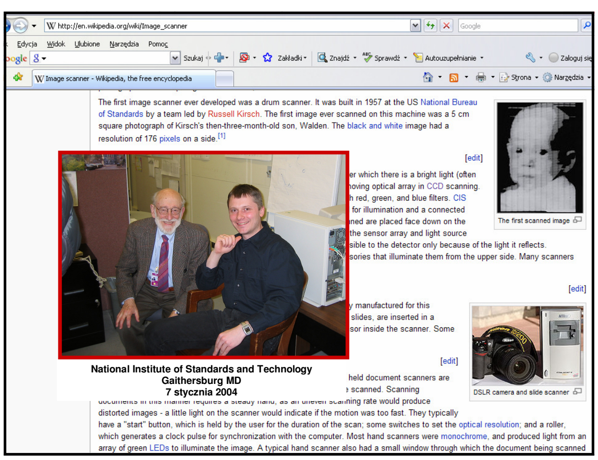
Film [edit]

"Slide" (positive) or negative film can be scanned in equipment specially manufactured for this purpose. Usually, uncut film strips of up to six frames, or four mounted slides, are inserted in a carrier, which is moved by a stepper motor across a lens and CCD sensor inside the scanner. Some models mainly used for same-size scans.

DSLR camera and slide scanner

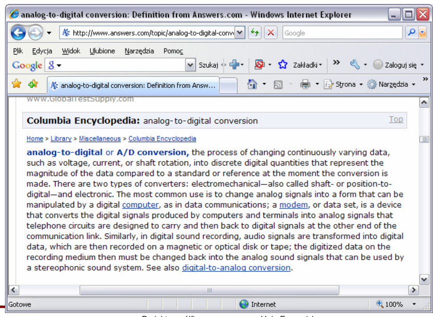
Hand [edit]

Hand scanners come in two forms: document and 3D scanners. Hand held document scanners are manual devices that are dragged across the surface of the image to be scanned. Scanning documents in this manner requires a steady hand, as an uneven scanning rate would produce distorted images - a little light on the scanner would indicate if the motion was too fast. They typically have a "start" button, which is held by the user for the duration of the scan; some switches to set the optical resolution; and a roller, which generates a clock pulse for synchronization with the computer. Most hand scanners were monochrome, and produced light from an array of green LEDs to illuminate the image. A typical hand scanner also had a small window through which the document being scanned



Digitization

analog-to-digital conversion


analog-to-digital conversion: Definition from Answers.com - Windows Internet Explorer

Columbia Encyclopedia: analog-to-digital conversion

Home > Library > Miscellaneous > Columbia Encyclopedia

analog-to-digital or **A/D conversion,** the process of changing continuously varying data, such as voltage, current, or shaft rotation, into discrete digital quantities that represent the magnitude of the data compared to a standard or reference at the moment the conversion is made. There are two types of converters: electromechanical—also called shaft- or position-to-digital—and electronic. The most common use is to change analog signals into a form that can be manipulated by a digital computer, as in data communications; a modem, or data set, is a device that converts the digital signals produced by computers and terminals into analog signals that telephone circuits are designed to carry and then back to digital signals at the other end of the communication link. Similarly, in digital sound recording, audio signals are transformed into digital data, which are then recorded on a magnetic or optical disk or tape; the digitized data on the recording medium then must be changed back into the analog sound signals that can be used by a stereophonic sound system. See also digital-to-analog conversion.

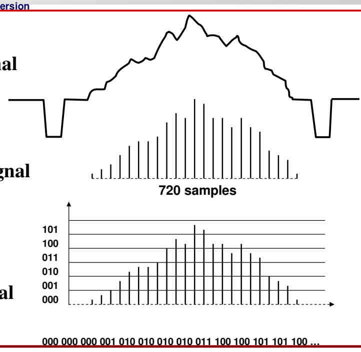
Digitization

analog-to-digital conversion

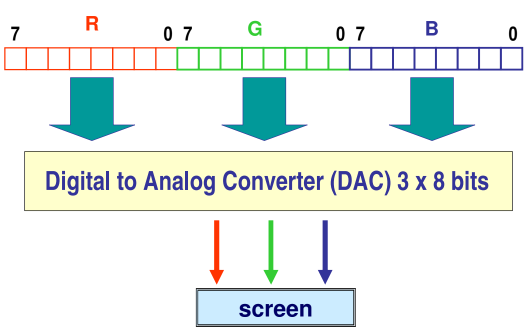
Analog signal

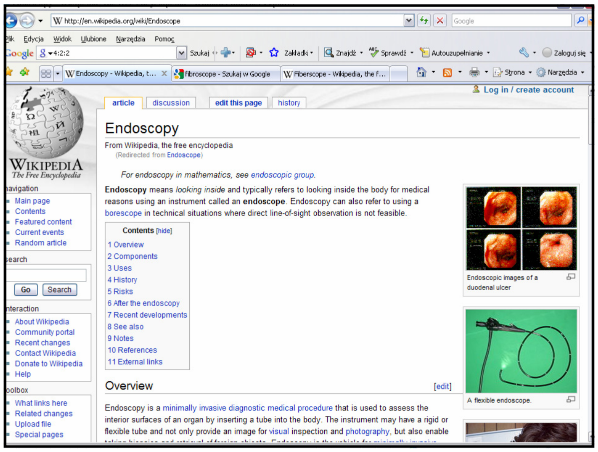
Sampled signal

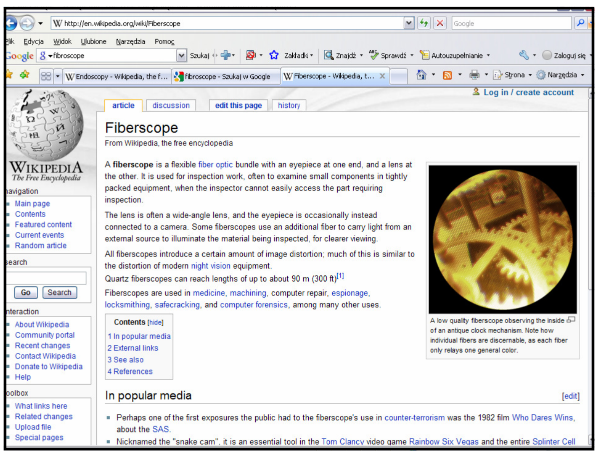
Digital signal



Colour coding in SVGA graphics cards

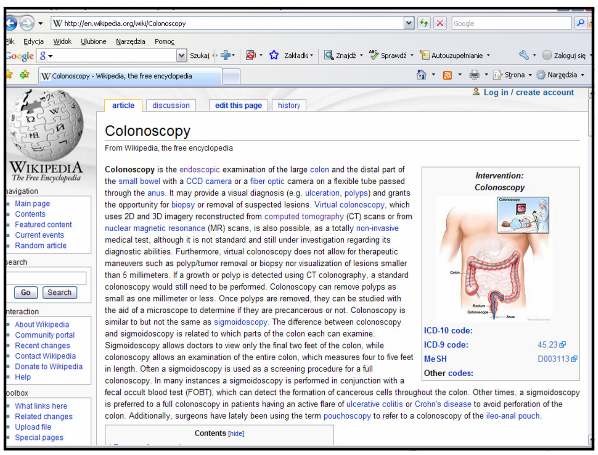



http://en.wikipedia.org/wiki/Endoscope
Endoscopy
From Wikipedia, the free encyclopedia
(Redirected from Endoscope)
For endoscopy in mathematics, see endoscopic group.
Endoscopy means looking inside and typically refers to looking inside the body for medical reasons using an instrument called an endoscope. Endoscopy can also refer to using a borescope in technical situations where direct line-of-sight observation is not feasible.
Contents [hide]
1 Overview
2 Components
3 Uses
4 History
5 Risks
6 After the endoscopy
7 Recent developments
8 See also
9 Notes
10 References
11 External links
Overview [edit]
Endoscopy is a minimally invasive diagnostic medical procedure that is used to assess the interior surfaces of an organ by inserting a tube into the body. The instrument may have a rigid or flexible tube and not only provide an image for visual inspection and photography, but also enable
Endoscopic images of a duodenal ulcer
A flexible endoscope.


http://en.wikipedia.org/wiki/Fiberscope
Fiberscope
From Wikipedia, the free encyclopedia
A fiberscope is a flexible fiber optic bundle with an eyepiece at one end, and a lens at the other. It is used for inspection work, often to examine small components in tightly packed equipment, when the inspector cannot easily access the part requiring inspection.
The lens is often a wide-angle lens, and the eyepiece is occasionally instead connected to a camera. Some fiberscopes use an additional fiber to carry light from an external source to illuminate the material being inspected, for clearer viewing.
All fiberscopes introduce a certain amount of image distortion; much of this is similar to the distortion of modern night vision equipment.
Quartz fiberscopes can reach lengths of up to about 90 m (300 ft)[1]
Fiberscopes are used in medicine, machining, computer repair, espionage, locksmithing, safecracking, and computer forensics, among many other uses.
Contents [hide]
1 In popular media
2 External links
3 See also
4 References
In popular media [edit]
Perhaps one of the first exposures the public had to the fiberscope's use in counter-terrorism was the 1982 film Who Dares Wins, about the SAS.
Nicknamed the "snake cam", it is an essential tool in the Tom Clancy video game Rainbow Six Vegas and the entire Splinter Cell
A low quality fiberscope observing the inside of an antique clock mechanism. Note how individual fibers are discernable, as each fiber only relays one general color.


http://en.wikipedia.org/wiki/Bronchoscopy
Bronchoscopy
From Wikipedia, the free encyclopedia
Bronchoscopy is a technique of visualizing the inside of the airways for diagnostic and therapeutic purposes. An instrument (bronchoscope) is inserted into the airways, usually through the nose or mouth, or occasionally through a tracheostomy. This allows the practitioner to examine the patient's airways for abnormalities such as foreign bodies, bleeding, tumors, or inflammation. Specimens may be taken from inside the lungs: biopsies, fluid (bronchoalveolar lavage), or endobronchial brushing. The construction of bronchoscopes ranges from rigid metal tubes with attached lighting devices to flexible fibreoptic instruments with realtime video equipment.
Contents [hide]
1 History
2 Types
2.1 Rigid
2.2 Flexible (fiberoptic)
3 Purposes
3.1 Diagnostic
3.2 Therapeutic
4 Procedure
5 Recovery
6 Complications and Risks
7 See also
8 References
History [edit]
A physician performing bronchoscopy.

http://en.wikipedia.org/wiki/Gastroscopy
article discussion edit this page history
Log in / create account
Esophagogastroduodenoscopy
From Wikipedia, the free encyclopedia
(Redirected from Gastroscopy)
"EGD" redirects here. For the computer software Entropy Gathering Daemon, see /dev/random.
"OGD" redirects here. For the IATA airport code, see Ogden-Hinckley Airport.
In medicine (gastroenterology), esophagogastroduodenoscopy is a diagnostic endoscopic procedure that visualizes the upper part of the gastrointestinal tract up to the duodenum. It is considered a minimally invasive procedure since it does not require an incision into one of the major body cavities and does not require any significant recovery after the procedure (unless sedation or anaesthesia has been used). A sore throat is also common.[1][2][3]
Contents [hide]
1 Alternative names
2 Indications
2.1 Diagnostic
2.2 Surveillance
2.3 Confirmation of diagnosis/biopsy
2.4 Therapeutic
2.5 Newer interventions
3 Equipment
4 Procedure
5 Complications
6 Limitations
7 Additional images
8 References
Intervention: Esophagogastroduodenoscopy
Endoscopic still of esophageal ulcers seen after banding of esophageal varices, at time of esophagogastroduodenoscopy
ICD-10 code:
ICD-9 code: 45.13
MeSH D016145
Other codes:



http://en.wikipedia.org/wiki/Colonoscopy
article discussion edit this page history
Log in / create account
Colonoscopy
From Wikipedia, the free encyclopedia
Colonoscopy is the endoscopic examination of the large colon and the distal part of the small bowel with a CCD camera or a fiber optic camera on a flexible tube passed through the anus. It may provide a visual diagnosis (e.g. ulceration, polyps) and grants the opportunity for biopsy or removal of suspected lesions. Virtual colonoscopy, which uses 2D and 3D imagery reconstructed from computed tomography (CT) scans or from nuclear magnetic resonance (MR) scans, is also possible, as a totally non-invasive medical test, although it is not standard and still under investigation regarding its diagnostic abilities. Furthermore, virtual colonoscopy does not allow for therapeutic maneuvers such as polyp/tumor removal or biopsy nor visualization of lesions smaller than 5 millimeters. If a growth or polyp is detected using CT colonography, a standard colonoscopy would still need to be performed. Colonoscopy can remove polyps as small as one millimeter or less. Once polyps are removed, they can be studied with the aid of a microscope to determine if they are precancerous or not. Colonoscopy is similar to but not the same as sigmoidoscopy. The difference between colonoscopy and sigmoidoscopy is related to which parts of the colon each can examine. Sigmoidoscopy allows doctors to view only the final two feet of the colon, while colonoscopy allows an examination of the entire colon, which measures four to five feet in length. Often a sigmoidoscopy is used as a screening procedure for a full colonoscopy. In many instances a sigmoidoscopy is performed in conjunction with a fecal occult blood test (FOBT), which can detect the formation of cancerous cells throughout the colon. Other times, a sigmoidoscopy is preferred to a full colonoscopy in patients having an active flare of ulcerative colitis or Crohn's disease to avoid perforation of the colon. Additionally, surgeons have lately been using the term pouchoscopy to refer to a colonoscopy of the ileo-anal pouch.
Intervention: Colonoscopy
ICD-10 code:
ICD-9 code: 45.23
MeSH D003113
Other codes:
Contents [hide]

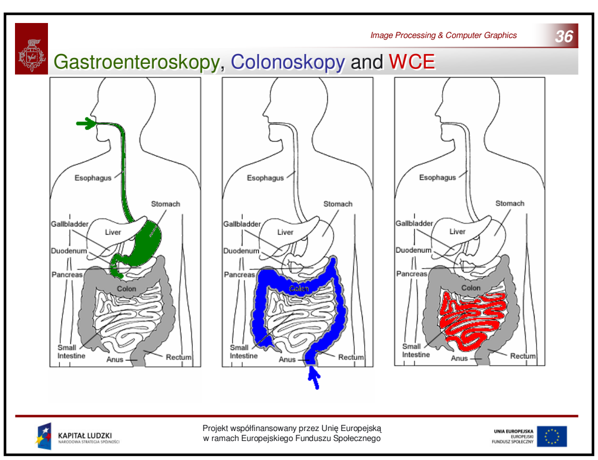
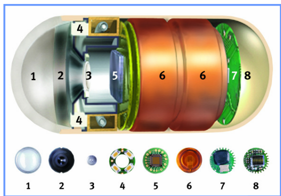
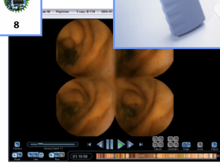


Image Processing & Computer Graphics
36
Gastroenteroskopy, Colonoskopy and WCE
Esophagus
Stomach
Gallbladder
Liver
Duodenum
Pancreas
Colon
Small Intestine
Anus
Rectum
KAPITAŁ LUDZKI
Projekt współfinansowany przez Unię Europejską
w ramach Europejskiego Funduszu Społecznego
UNIA EUROPEJSKA
EUROPEJSKI FUNDUSZ SPOŁECZNY

WCE - Wireless Capsule Endoscopy

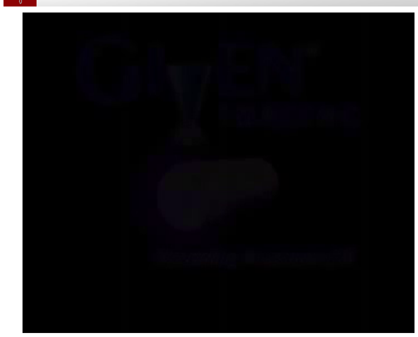


11mm x 26mm, 3.7 g



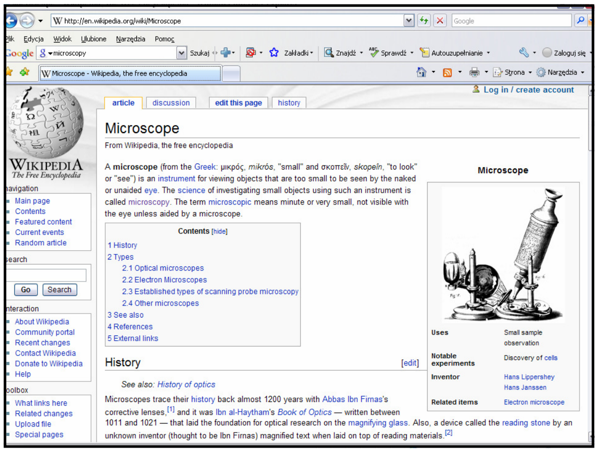
[GivenImaging]
www.givenimaging.com

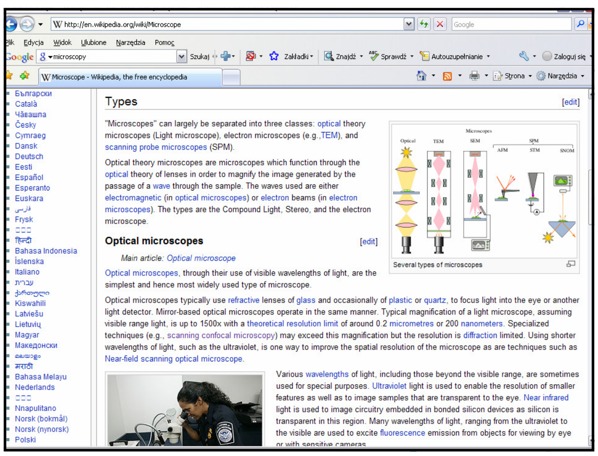
WCE - Wireless Capsule Endoscopy

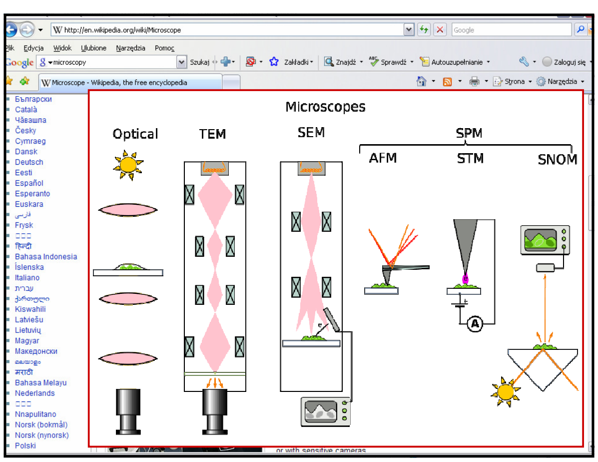


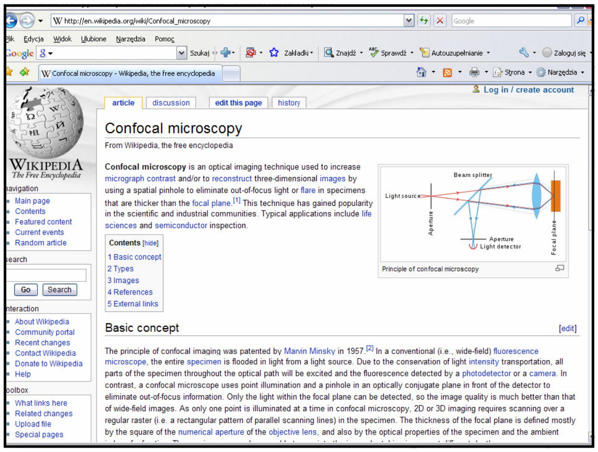
[GivenImaging]
www.givenimaging.com

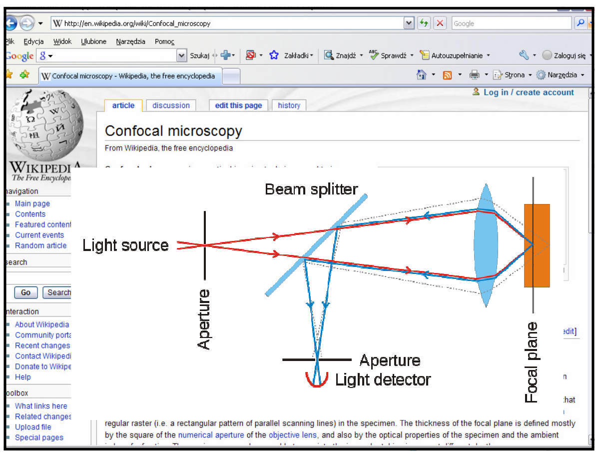
WCE - Wireless Capsule Endoscopy

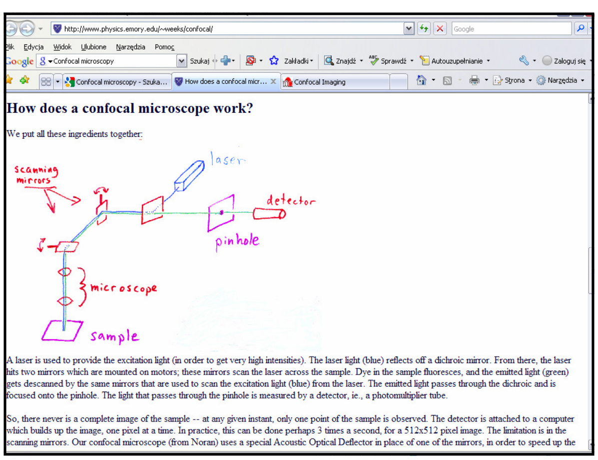

http://en.wikipedia.org/wiki/Microscope
Microscope - Wikipedia, the free encyclopedia
article
discussion
edit this page
history
Log in / create account
Microscope
From Wikipedia, the free encyclopedia
A microscope (from the Greek: μικρός, mikrós, "small" and σκοπεῖν, skopeîn, "to look" or "see") is an instrument for viewing objects that are too small to be seen by the naked or unaided eye. The science of investigating small objects using such an instrument is called microscopy. The term microscopic means minute or very small, not visible with the eye unless aided by a microscope.
Contents [hide]
1 History
2 Types
2.1 Optical microscopes
2.2 Electron Microscopes
2.3 Established types of scanning probe microscopy
2.4 Other microscopes
3 See also
4 References
5 External links
History [edit]
See also: History of optics
Microscopes trace their history back almost 1200 years with Abbas Ibn Firnas's corrective lenses,[1] and it was Ibn al-Haytham's Book of Optics — written between 1011 and 1021 — that laid the foundation for optical research on the magnifying glass. Also, a device called the reading stone by an unknown inventor (thought to be Ibn Firnas) magnified text when laid on top of reading materials.[2]
Microscope
Uses Small sample observation
Notable experiments Discovery of cells
Inventor Hans Lippershey Hans Janssen
Related items Electron microscope

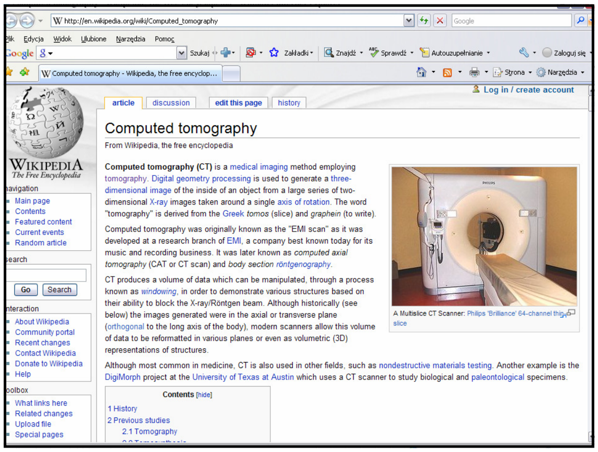

http://en.wikipedia.org/wiki/Microscope
Microscope - Wikipedia, the free encyclopedia
Types [edit]
"Microscopes" can largely be separated into three classes: optical theory microscopes (Light microscope), electron microscopes (e.g., TEM), and scanning probe microscopes (SPM).
Optical theory microscopes are microscopes which function through the optical theory of lenses in order to magnify the image generated by the passage of a wave through the sample. The waves used are either electromagnetic (in optical microscopes) or electron beams (in electron microscopes). The types are the Compound Light, Stereo, and the electron microscope.
Optical microscopes [edit]
Main article: Optical microscope
Optical microscopes, through their use of visible wavelengths of light, are the simplest and hence most widely used type of microscope.
Optical microscopes typically use refractive lenses of glass and occasionally of plastic or quartz, to focus light into the eye or another light detector. Mirror-based optical microscopes operate in the same manner. Typical magnification of a light microscope, assuming visible range light, is up to 1500x with a theoretical resolution limit of around 0.2 micrometres or 200 nanometers. Specialized techniques (e.g., scanning confocal microscopy) may exceed this magnification but the resolution is diffraction limited. Using shorter wavelengths of light, such as the ultraviolet, is one way to improve the spatial resolution of the microscope as are techniques such as Near-field scanning optical microscope.
Various wavelengths of light, including those beyond the visible range, are sometimes used for special purposes. Ultraviolet light is used to enable the resolution of smaller features as well as to image samples that are transparent to the eye. Near infrared light is used to image circuitry embedded in bonded silicon devices as silicon is transparent in this region. Many wavelengths of light, ranging from the ultraviolet to the visible are used to excite fluorescence emission from objects for viewing by eye or with sensitive cameras.
Several types of microscopes


Microscopes
Optical
TEM
SEM
SPM
AFM
STM
SNOM
A


http://en.wikipedia.org/wiki/Confocal_microscopy
Confocal microscopy - Wikipedia, the free encyclopedia
Log in / create account
article
discussion
edit this page
history
Confocal microscopy
From Wikipedia, the free encyclopedia
Confocal microscopy is an optical imaging technique used to increase micrograph contrast and/or to reconstruct three-dimensional images by using a spatial pinhole to eliminate out-of-focus light or flare in specimens that are thicker than the focal plane.[1] This technique has gained popularity in the scientific and industrial communities. Typical applications include life sciences and semiconductor inspection.
Contents [hide]
1 Basic concept
2 Types
3 Images
4 References
5 External links
Beam splitter
Light source
Aperture
Aperture
Light detector
Focal plane
Principle of confocal microscopy
Basic concept [edit]
The principle of confocal imaging was patented by Marvin Minsky in 1957.[2] In a conventional (i.e., wide-field) fluorescence microscope, the entire specimen is flooded in light from a light source. Due to the conservation of light intensity transportation, all parts of the specimen throughout the optical path will be excited and the fluorescence detected by a photodetector or a camera. In contrast, a confocal microscope uses point illumination and a pinhole in an optically conjugate plane in front of the detector to eliminate out-of-focus information. Only the light within the focal plane can be detected, so the image quality is much better than that of wide-field images. As only one point is illuminated at a time in confocal microscopy, 2D or 3D imaging requires scanning over a regular raster (i.e. a rectangular pattern of parallel scanning lines) in the specimen. The thickness of the focal plane is defined mostly by the square of the numerical aperture of the objective lens, and also by the optical properties of the specimen and the ambient


http://en.wikipedia.org/wiki/Confocal_microscopy
Confocal microscopy
From Wikipedia, the free encyclopedia
Beam splitter
Light source
Aperture
Aperture
Light detector
Focal plane
regular raster (i.e. a rectangular pattern of parallel scanning lines) in the specimen. The thickness of the focal plane is defined mostly by the square of the numerical aperture of the objective lens, and also by the optical properties of the specimen and the ambient


http://www.physics.emory.edu/~weeks/confocal/
How does a confocal microscope work?
We put all these ingredients together:
laser
scanning mirrors
detector
pinhole
microscope
sample
A laser is used to provide the excitation light (in order to get very high intensities). The laser light (blue) reflects off a dichroic mirror. From there, the laser hits two mirrors which are mounted on motors; these mirrors scan the laser across the sample. Dye in the sample fluoresces, and the emitted light (green) gets descanned by the same mirrors that are used to scan the excitation light (blue) from the laser. The emitted light passes through the dichroic and is focused onto the pinhole. The light that passes through the pinhole is measured by a detector, ie., a photomultiplier tube.
So, there never is a complete image of the sample -- at any given instant, only one point of the sample is observed. The detector is attached to a computer which builds up the image, one pixel at a time. In practice, this can be done perhaps 3 times a second, for a 512x512 pixel image. The limitation is in the scanning mirrors. Our confocal microscope (from Noran) uses a special Acoustic Optical Deflector in place of one of the mirrors, in order to speed up the


http://en.wikipedia.org/wiki/Computed_tomography
Computed tomography
From Wikipedia, the free encyclopedia
Computed tomography (CT) is a medical imaging method employing tomography. Digital geometry processing is used to generate a three-dimensional image of the inside of an object from a large series of two-dimensional X-ray images taken around a single axis of rotation. The word "tomography" is derived from the Greek tomos (slice) and graphein (to write).
Computed tomography was originally known as the "EMI scan" as it was developed at a research branch of EMI, a company best known today for its music and recording business. It was later known as computed axial tomography (CAT or CT scan) and body section röntgenography.
CT produces a volume of data which can be manipulated, through a process known as windowing, in order to demonstrate various structures based on their ability to block the X-ray/Röntgen beam. Although historically (see below) the images generated were in the axial or transverse plane (orthogonal to the long axis of the body), modern scanners allow this volume of data to be reformatted in various planes or even as volumetric (3D) representations of structures.
Although most common in medicine, CT is also used in other fields, such as nondestructive materials testing. Another example is the DigiMorph project at the University of Texas at Austin which uses a CT scanner to study biological and paleontological specimens.
A Multislice CT Scanner: Philips 'Brilliance' 64-channel thin slice
Contents [hide]
1 History
2 Previous studies
2.1 Tomography

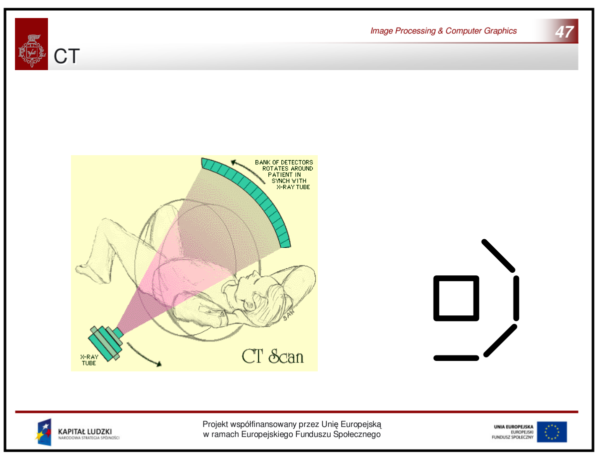
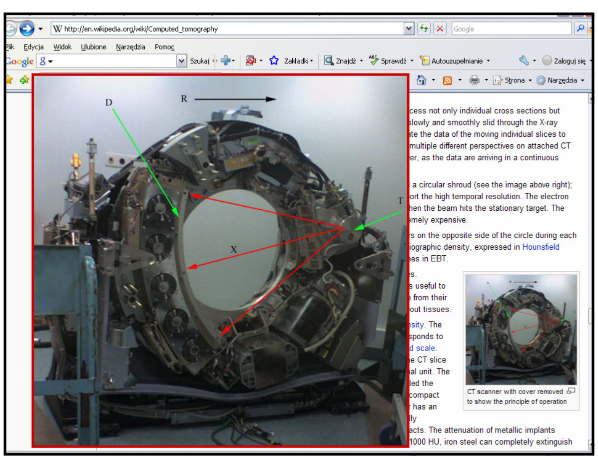
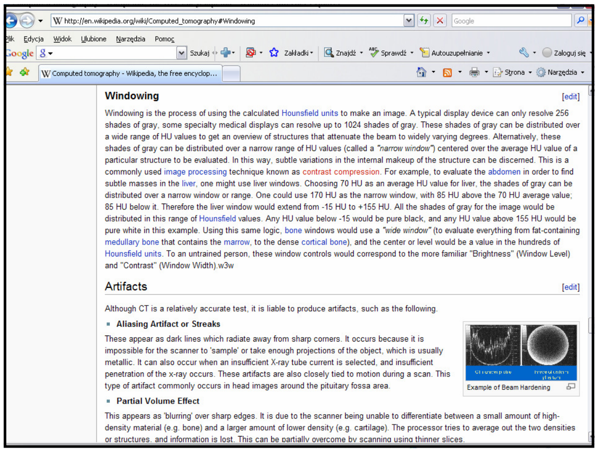


Image Processing & Computer Graphics
47
CT
BANK OF DETECTORS ROTATES AROUND PATIENT IN SYNCH WITH X-RAY TUBE
X-RAY TUBE
CT Scan
KAPITAŁ LUDZKI
Projekt współfinansowany przez Unię Europejską
w ramach Europejskiego Funduszu Społecznego
UNIA EUROPEJSKA EUROPEJSKI FUNDUSZ SPOŁECZNY


http://en.wikipedia.org/wiki/Computed_tomography
D
R
T
X
CT scanner with cover removed to show the principle of operation



http://en.wikipedia.org/wiki/Computed_tomography#Windowing

Windowing [edit]

Windowing is the process of using the calculated Hounsfield units to make an image. A typical display device can only resolve 256 shades of gray, some specialty medical displays can resolve up to 1024 shades of gray. These shades of gray can be distributed over a wide range of HU values to get an overview of structures that attenuate the beam to widely varying degrees. Alternatively, these shades of gray can be distributed over a narrow range of HU values (called a *"narrow window"*) centered over the average HU value of a particular structure to be evaluated. In this way, subtle variations in the internal makeup of the structure can be discerned. This is a commonly used image processing technique known as contrast compression. For example, to evaluate the abdomen in order to find subtle masses in the liver, one might use liver windows. Choosing 70 HU as an average HU value for liver, the shades of gray can be distributed over a narrow window or range. One could use 170 HU as the narrow window, with 85 HU above the 70 HU average value; 85 HU below it. Therefore the liver window would extend from -15 HU to +155 HU. All the shades of gray for the image would be distributed in this range of Hounsfield values. Any HU value below -15 would be pure black, and any HU value above 155 HU would be pure white in this example. Using this same logic, bone windows would use a *"wide window"* (to evaluate everything from fat-containing medullary bone that contains the marrow, to the dense cortical bone), and the center or level would be a value in the hundreds of Hounsfield units. To an untrained person, these window controls would correspond to the more familiar "Brightness" (Window Level) and "Contrast" (Window Width).w3w

Artifacts [edit]

Although CT is a relatively accurate test, it is liable to produce artifacts, such as the following.

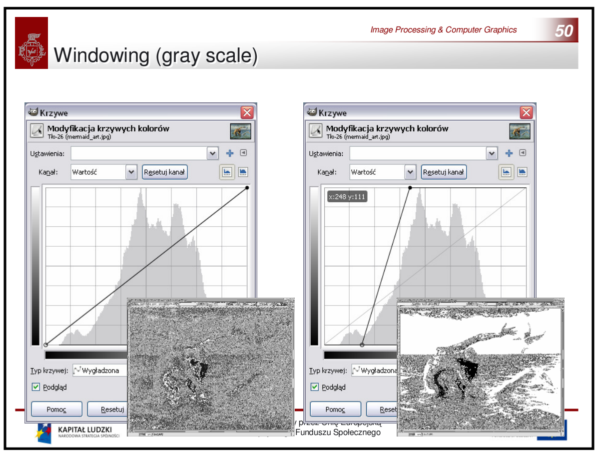
- **Aliasing Artifact or Streaks**

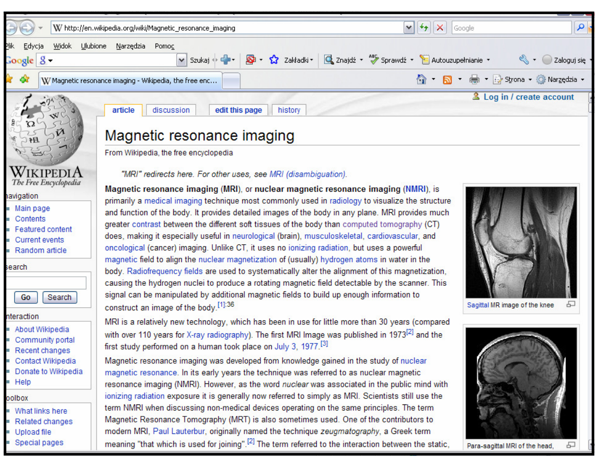
These appear as dark lines which radiate away from sharp corners. It occurs because it is impossible for the scanner to 'sample' or take enough projections of the object, which is usually metallic. It can also occur when an insufficient X-ray tube current is selected, and insufficient penetration of the x-ray occurs. These artifacts are also closely tied to motion during a scan. This type of artifact commonly occurs in head images around the pituitary fossa area.

Example of Beam Hardening

- **Partial Volume Effect**

This appears as 'blurring' over sharp edges. It is due to the scanner being unable to differentiate between a small amount of high-density material (e.g. bone) and a larger amount of lower density (e.g. cartilage). The processor tries to average out the two densities or structures, and information is lost. This can be partially overcome by scanning using thinner slices.





http://en.wikipedia.org/wiki/Magnetic_resonance_imaging

Magnetic resonance imaging

From Wikipedia, the free encyclopedia

"MRI" redirects here. For other uses, see MRI (disambiguation).

Magnetic resonance imaging (**MRI**), or **nuclear magnetic resonance imaging** (**NMRI**), is primarily a medical imaging technique most commonly used in radiology to visualize the structure and function of the body. It provides detailed images of the body in any plane. MRI provides much greater contrast between the different soft tissues of the body than computed tomography (CT) does, making it especially useful in neurological (brain), musculoskeletal, cardiovascular, and oncological (cancer) imaging. Unlike CT, it uses no ionizing radiation, but uses a powerful magnetic field to align the nuclear magnetization of (usually) hydrogen atoms in water in the body. Radiofrequency fields are used to systematically alter the alignment of this magnetization, causing the hydrogen nuclei to produce a rotating magnetic field detectable by the scanner. This signal can be manipulated by additional magnetic fields to build up enough information to construct an image of the body.[1]:36

Sagittal MR image of the knee

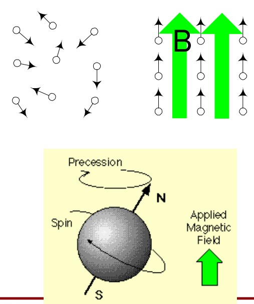
MRI is a relatively new technology, which has been in use for little more than 30 years (compared with over 110 years for X-ray radiography). The first MRI Image was published in 1973[2] and the first study performed on a human took place on July 3, 1977.[3]

Magnetic resonance imaging was developed from knowledge gained in the study of nuclear magnetic resonance. In its early years the technique was referred to as nuclear magnetic resonance imaging (NMRI). However, as the word *nuclear* was associated in the public mind with ionizing radiation exposure it is generally now referred to simply as MRI. Scientists still use the term NMRI when discussing non-medical devices operating on the same principles. The term Magnetic Resonance Tomography (MRT) is also sometimes used. One of the contributors to modern MRI, Paul Lauterbur, originally named the technique *zeugmatography*, a Greek term meaning "that which is used for joining".[2] The term referred to the interaction between the static,

Para-sagittal MRI of the head,

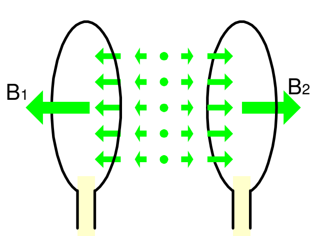
MRI

MRI

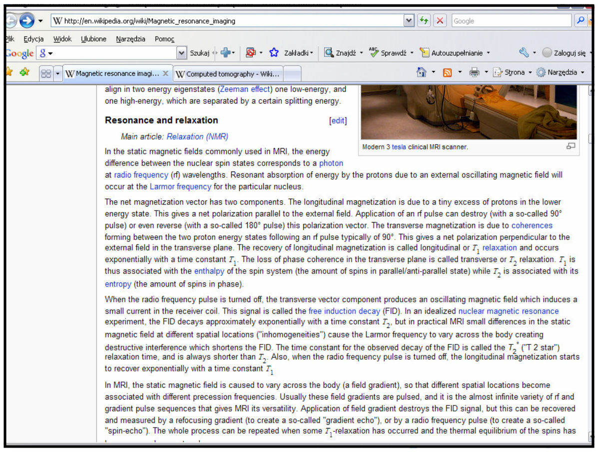


- Protons (in hydrogen) have spin
- Spins are directed by B
- Precession
- Precession frequency depends on B

MRI



- Magnetic gradients
- Coil pairs in x, y, z directions



align in two energy eigenstates (Zeeman effect) one low-energy, and one high-energy, which are separated by a certain splitting energy.

Resonance and relaxation

[edit]

Main article: Relaxation (NMR)

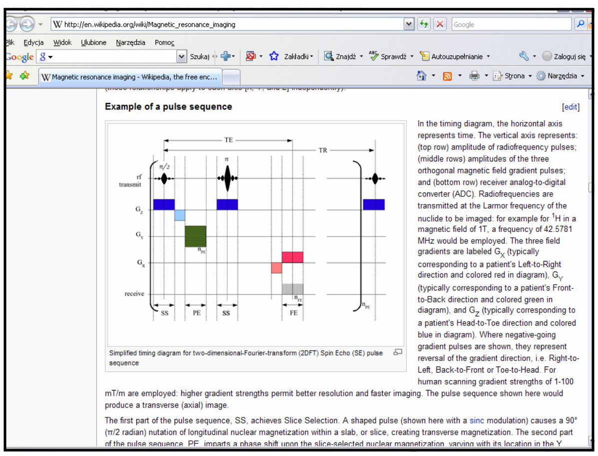
Modern 3 tesla clinical MRI scanner.

In the static magnetic fields commonly used in MRI, the energy difference between the nuclear spin states corresponds to a photon at radio frequency (rf) wavelengths. Resonant absorption of energy by the protons due to an external oscillating magnetic field will occur at the Larmor frequency for the particular nucleus.

The net magnetization vector has two components. The longitudinal magnetization is due to a tiny excess of protons in the lower energy state. This gives a net polarization parallel to the external field. Application of an rf pulse can destroy (with a so-called 90° pulse) or even reverse (with a so-called 180° pulse) this polarization vector. The transverse magnetization is due to coherences forming between the two proton energy states following an rf pulse typically of 90°. This gives a net polarization perpendicular to the external field in the transverse plane. The recovery of longitudinal magnetization is called longitudinal or T_1 relaxation and occurs exponentially with a time constant T_1. The loss of phase coherence in the transverse plane is called transverse or T_2 relaxation. T_1 is thus associated with the enthalpy of the spin system (the amount of spins in parallel/anti-parallel state) while T_2 is associated with its entropy (the amount of spins in phase).

When the radio frequency pulse is turned off, the transverse vector component produces an oscillating magnetic field which induces a small current in the receiver coil. This signal is called the free induction decay (FID). In an idealized nuclear magnetic resonance experiment, the FID decays approximately exponentially with a time constant T_2, but in practical MRI small differences in the static magnetic field at different spatial locations ("inhomogeneities") cause the Larmor frequency to vary across the body creating destructive interference which shortens the FID. The time constant for the observed decay of the FID is called the T_2^* ("T 2 star") relaxation time, and is always shorter than T_2. Also, when the radio frequency pulse is turned off, the longitudinal magnetization starts to recover exponentially with a time constant T_1

In MRI, the static magnetic field is caused to vary across the body (a field gradient), so that different spatial locations become associated with different precession frequencies. Usually these field gradients are pulsed, and it is the almost infinite variety of rf and gradient pulse sequences that gives MRI its versatility. Application of field gradient destroys the FID signal, but this can be recovered and measured by a refocusing gradient (to create a so-called "gradient echo"), or by a radio frequency pulse (to create a so-called "spin-echo"). The whole process can be repeated when some T_1-relaxation has occurred and the thermal equilibrium of the spins has



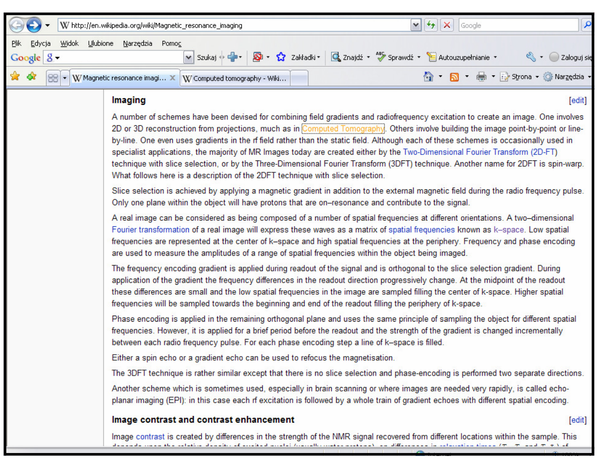
Example of a pulse sequence

[edit]

Simplified timing diagram for two-dimensional-Fourier-transform (2DFT) Spin Echo (SE) pulse sequence

In the timing diagram, the horizontal axis represents time. The vertical axis represents: (top row) amplitude of radiofrequency pulses; (middle rows) amplitudes of the three orthogonal magnetic field gradient pulses; and (bottom row) receiver analog-to-digital converter (ADC). Radiofrequencies are transmitted at the Larmor frequency of the nuclide to be imaged: for example for ^1H in a magnetic field of 1T, a frequency of 42.5781 MHz would be employed. The three field gradients are labeled G_X (typically corresponding to a patient's Left-to-Right direction and colored red in diagram), G_Y (typically corresponding to a patient's Front-to-Back direction and colored green in diagram), and G_Z (typically corresponding to a patient's Head-to-Toe direction and colored blue in diagram). Where negative-going gradient pulses are shown, they represent reversal of the gradient direction, i.e. Right-to-Left, Back-to-Front or Toe-to-Head. For human scanning gradient strengths of 1-100 mT/m are employed: higher gradient strengths permit better resolution and faster imaging. The pulse sequence shown here would produce a transverse (axial) image.

The first part of the pulse sequence, SS, achieves Slice Selection. A shaped pulse (shown here with a sinc modulation) causes a 90° (π/2 radian) nutation of longitudinal nuclear magnetization within a slab, or slice, creating transverse magnetization. The second part of the pulse sequence, PE, imparts a phase shift upon the slice-selected nuclear magnetization, varying with its location in the Y



Imaging

[edit]

A number of schemes have been devised for combining field gradients and radiofrequency excitation to create an image. One involves 2D or 3D reconstruction from projections, much as in Computed Tomography. Others involve building the image point-by-point or line-by-line. One even uses gradients in the rf field rather than the static field. Although each of these schemes is occasionally used in specialist applications, the majority of MR Images today are created either by the Two-Dimensional Fourier Transform (2D-FT) technique with slice selection, or by the Three-Dimensional Fourier Transform (3DFT) technique. Another name for 2DFT is spin-warp. What follows here is a description of the 2DFT technique with slice selection.

Slice selection is achieved by applying a magnetic gradient in addition to the external magnetic field during the radio frequency pulse. Only one plane within the object will have protons that are on–resonance and contribute to the signal.

A real image can be considered as being composed of a number of spatial frequencies at different orientations. A two–dimensional Fourier transformation of a real image will express these waves as a matrix of spatial frequencies known as k–space. Low spatial frequencies are represented at the center of k–space and high spatial frequencies at the periphery. Frequency and phase encoding are used to measure the amplitudes of a range of spatial frequencies within the object being imaged.

The frequency encoding gradient is applied during readout of the signal and is orthogonal to the slice selection gradient. During application of the gradient the frequency differences in the readout direction progressively change. At the midpoint of the readout these differences are small and the low spatial frequencies in the image are sampled filling the center of k-space. Higher spatial frequencies will be sampled towards the beginning and end of the readout filling the periphery of k-space.

Phase encoding is applied in the remaining orthogonal plane and uses the same principle of sampling the object for different spatial frequencies. However, it is applied for a brief period before the readout and the strength of the gradient is changed incrementally between each radio frequency pulse. For each phase encoding step a line of k–space is filled.

Either a spin echo or a gradient echo can be used to refocus the magnetisation.

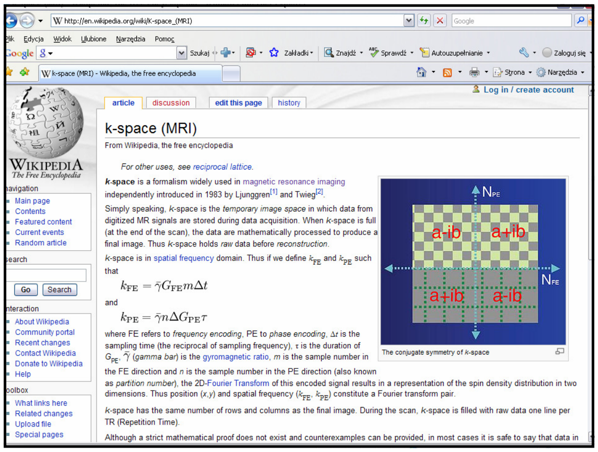
The 3DFT technique is rather similar except that there is no slice selection and phase-encoding is performed two separate directions.

Another scheme which is sometimes used, especially in brain scanning or where images are needed very rapidly, is called echo-planar imaging (EPI): in this case each rf excitation is followed by a whole train of gradient echoes with different spatial encoding.

Image contrast and contrast enhancement

[edit]

Image contrast is created by differences in the strength of the NMR signal recovered from different locations within the sample. This



http://en.wikipedia.org/wiki/K-space_(MRI)

k-space (MRI)

From Wikipedia, the free encyclopedia

For other uses, see reciprocal lattice.

***k*-space** is a formalism widely used in magnetic resonance imaging independently introduced in 1983 by Ljunggren[1] and Twieg[2].

Simply speaking, *k*-space is the *temporary image space* in which data from digitized MR signals are stored during data acquisition. When *k*-space is full (at the end of the scan), the data are mathematically processed to produce a final image. Thus *k*-space holds *raw* data before *reconstruction*.

k-space is in spatial frequency domain. Thus if we define k_{FE} and k_{PE} such that

$$k_{\mathrm{FE}} = \bar{\gamma} G_{\mathrm{FE}} m \Delta t$$

and

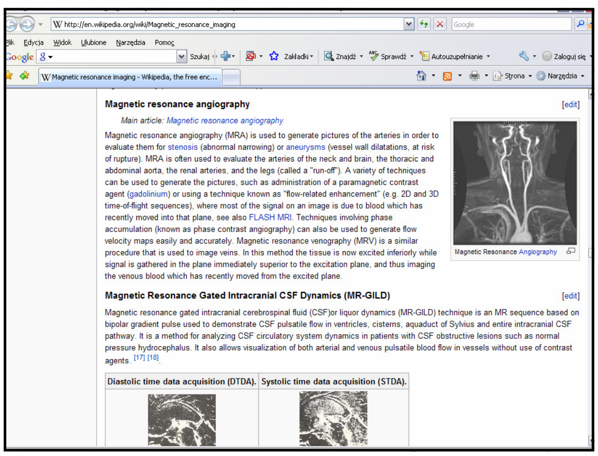
$$k_{\mathrm{PE}} = \bar{\gamma} n \Delta G_{\mathrm{PE}} \tau$$

where FE refers to *frequency encoding*, PE to *phase encoding*, Δt is the sampling time (the reciprocal of sampling frequency), τ is the duration of G_{PE}, $\bar{\gamma}$ (*gamma bar*) is the gyromagnetic ratio, *m* is the sample number in the FE direction and *n* is the sample number in the PE direction (also known as *partition number*), the 2D-Fourier Transform of this encoded signal results in a representation of the spin density distribution in two dimensions. Thus position (*x*,*y*) and spatial frequency (k_{FE}, k_{PE}) constitute a Fourier transform pair.

k-space has the same number of rows and columns as the final image. During the scan, *k*-space is filled with raw data one line per TR (Repetition Time).

Although a strict mathematical proof does not exist and counterexamples can be provided, in most cases it is safe to say that data in

The conjugate symmetry of *k*-space



http://en.wikipedia.org/wiki/Magnetic_resonance_imaging

Magnetic resonance angiography

Main article: Magnetic resonance angiography

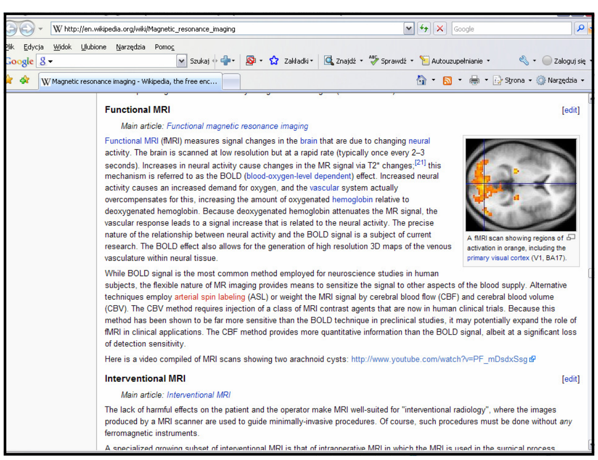
Magnetic resonance angiography (MRA) is used to generate pictures of the arteries in order to evaluate them for stenosis (abnormal narrowing) or aneurysms (vessel wall dilatations, at risk of rupture). MRA is often used to evaluate the arteries of the neck and brain, the thoracic and abdominal aorta, the renal arteries, and the legs (called a "run-off"). A variety of techniques can be used to generate the pictures, such as administration of a paramagnetic contrast agent (gadolinium) or using a technique known as "flow-related enhancement" (e.g. 2D and 3D time-of-flight sequences), where most of the signal on an image is due to blood which has recently moved into that plane, see also FLASH MRI. Techniques involving phase accumulation (known as phase contrast angiography) can also be used to generate flow velocity maps easily and accurately. Magnetic resonance venography (MRV) is a similar procedure that is used to image veins. In this method the tissue is now excited inferiorly while signal is gathered in the plane immediately superior to the excitation plane, and thus imaging the venous blood which has recently moved from the excited plane.

Magnetic Resonance Angiography

Magnetic Resonance Gated Intracranial CSF Dynamics (MR-GILD)

Magnetic resonance gated intracranial cerebrospinal fluid (CSF)or liquor dynamics (MR-GILD) technique is an MR sequence based on bipolar gradient pulse used to demonstrate CSF pulsatile flow in ventricles, cisterns, aquaduct of Sylvius and entire intracranial CSF pathway. It is a method for analyzing CSF circulatory system dynamics in patients with CSF obstructive lesions such as normal pressure hydrocephalus. It also allows visualization of both arterial and venous pulsatile blood flow in vessels without use of contrast agents. [17] [18].

Diastolic time data acquisition (DTDA).	Systolic time data acquisition (STDA).



http://en.wikipedia.org/wiki/Magnetic_resonance_imaging

Functional MRI

Main article: Functional magnetic resonance imaging

Functional MRI (fMRI) measures signal changes in the brain that are due to changing neural activity. The brain is scanned at low resolution but at a rapid rate (typically once every 2–3 seconds). Increases in neural activity cause changes in the MR signal via T2* changes;[21] this mechanism is referred to as the BOLD (blood-oxygen-level dependent) effect. Increased neural activity causes an increased demand for oxygen, and the vascular system actually overcompensates for this, increasing the amount of oxygenated hemoglobin relative to deoxygenated hemoglobin. Because deoxygenated hemoglobin attenuates the MR signal, the vascular response leads to a signal increase that is related to the neural activity. The precise nature of the relationship between neural activity and the BOLD signal is a subject of current research. The BOLD effect also allows for the generation of high resolution 3D maps of the venous vasculature within neural tissue.

A fMRI scan showing regions of activation in orange, including the primary visual cortex (V1, BA17).

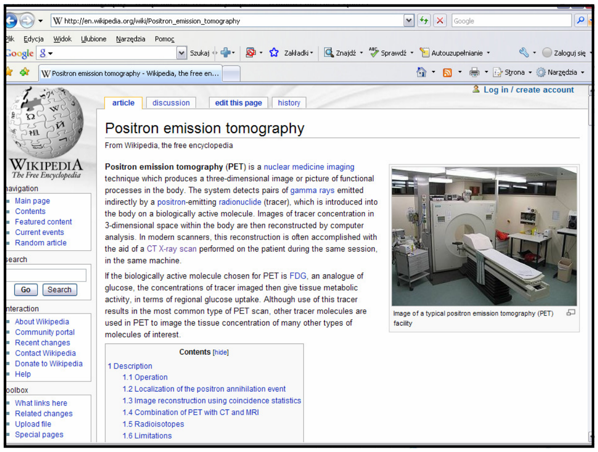
While BOLD signal is the most common method employed for neuroscience studies in human subjects, the flexible nature of MR imaging provides means to sensitize the signal to other aspects of the blood supply. Alternative techniques employ arterial spin labeling (ASL) or weight the MRI signal by cerebral blood flow (CBF) and cerebral blood volume (CBV). The CBV method requires injection of a class of MRI contrast agents that are now in human clinical trials. Because this method has been shown to be far more sensitive than the BOLD technique in preclinical studies, it may potentially expand the role of fMRI in clinical applications. The CBF method provides more quantitative information than the BOLD signal, albeit at a significant loss of detection sensitivity.

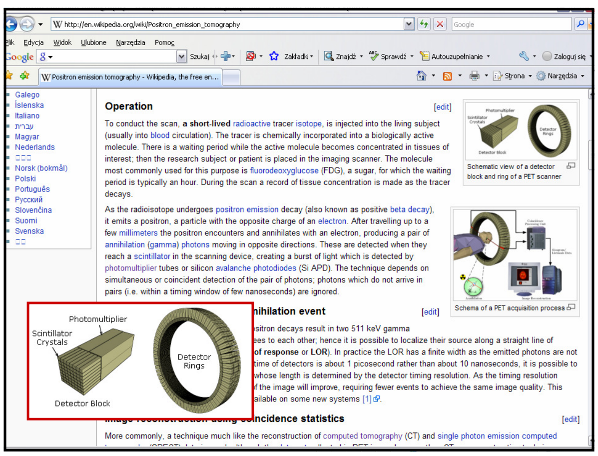
Here is a video compiled of MRI scans showing two arachnoid cysts: http://www.youtube.com/watch?v=PF_mDsdxSsg

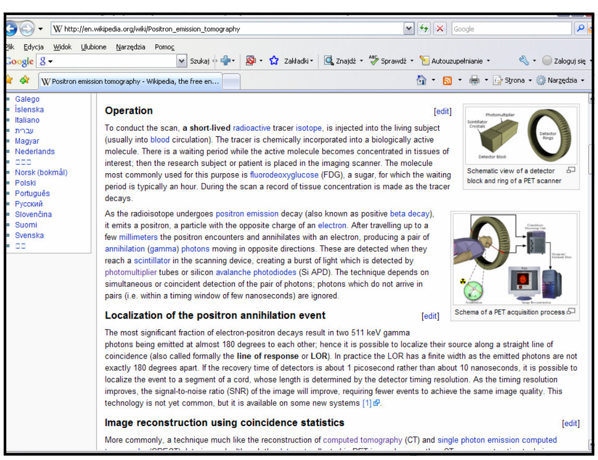
Interventional MRI

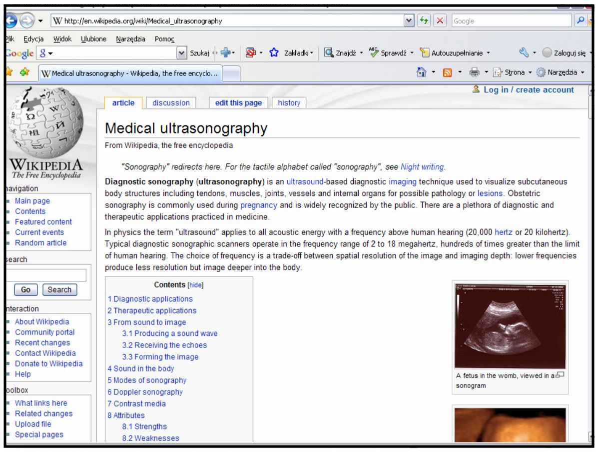
Main article: Interventional MRI

The lack of harmful effects on the patient and the operator make MRI well-suited for "interventional radiology", where the images produced by a MRI scanner are used to guide minimally-invasive procedures. Of course, such procedures must be done without *any* ferromagnetic instruments.


article
discussion
edit this page
history
Log in / create account
Positron emission tomography
From Wikipedia, the free encyclopedia
Positron emission tomography (PET) is a nuclear medicine imaging technique which produces a three-dimensional image or picture of functional processes in the body. The system detects pairs of gamma rays emitted indirectly by a positron-emitting radionuclide (tracer), which is introduced into the body on a biologically active molecule. Images of tracer concentration in 3-dimensional space within the body are then reconstructed by computer analysis. In modern scanners, this reconstruction is often accomplished with the aid of a CT X-ray scan performed on the patient during the same session, in the same machine.
If the biologically active molecule chosen for PET is FDG, an analogue of glucose, the concentrations of tracer imaged then give tissue metabolic activity, in terms of regional glucose uptake. Although use of this tracer results in the most common type of PET scan, other tracer molecules are used in PET to image the tissue concentration of many other types of molecules of interest.
Image of a typical positron emission tomography (PET) facility
Contents
1 Description
1.1 Operation
1.2 Localization of the positron annihilation event
1.3 Image reconstruction using coincidence statistics
1.4 Combination of PET with CT and MRI
1.5 Radioisotopes
1.6 Limitations


Operation
To conduct the scan, a short-lived radioactive tracer isotope, is injected into the living subject (usually into blood circulation). The tracer is chemically incorporated into a biologically active molecule. There is a waiting period while the active molecule becomes concentrated in tissues of interest; then the research subject or patient is placed in the imaging scanner. The molecule most commonly used for this purpose is fluorodeoxyglucose (FDG), a sugar, for which the waiting period is typically an hour. During the scan a record of tissue concentration is made as the tracer decays.
As the radioisotope undergoes positron emission decay (also known as positive beta decay), it emits a positron, a particle with the opposite charge of an electron. After travelling up to a few millimeters the positron encounters and annihilates with an electron, producing a pair of annihilation (gamma) photons moving in opposite directions. These are detected when they reach a scintillator in the scanning device, creating a burst of light which is detected by photomultiplier tubes or silicon avalanche photodiodes (Si APD). The technique depends on simultaneous or coincident detection of the pair of photons; photons which do not arrive in pairs (i.e. within a timing window of few nanoseconds) are ignored.
Schematic view of a detector block and ring of a PET scanner
Schema of a PET acquisition process
Photomultiplier
Scintillator Crystals
Detector Rings
Detector Block


Localization of the positron annihilation event
The most significant fraction of electron-positron decays result in two 511 keV gamma photons being emitted at almost 180 degrees to each other; hence it is possible to localize their source along a straight line of coincidence (also called formally the line of response or LOR). In practice the LOR has a finite width as the emitted photons are not exactly 180 degrees apart. If the recovery time of detectors is about 1 picosecond rather than about 10 nanoseconds, it is possible to localize the event to a segment of a cord, whose length is determined by the detector timing resolution. As the timing resolution improves, the signal-to-noise ratio (SNR) of the image will improve, requiring fewer events to achieve the same image quality. This technology is not yet common, but it is available on some new systems [1]
Image reconstruction using coincidence statistics
More commonly, a technique much like the reconstruction of computed tomography (CT) and single photon emission computed



http://en.wikipedia.org/wiki/Medical_ultrasonography

Medical ultrasonography

From Wikipedia, the free encyclopedia

"Sonography" redirects here. For the tactile alphabet called "sonography", see Night writing.

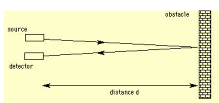
Diagnostic sonography (**ultrasonography**) is an ultrasound-based diagnostic imaging technique used to visualize subcutaneous body structures including tendons, muscles, joints, vessels and internal organs for possible pathology or lesions. Obstetric sonography is commonly used during pregnancy and is widely recognized by the public. There are a plethora of diagnostic and therapeutic applications practiced in medicine.

In physics the term "ultrasound" applies to all acoustic energy with a frequency above human hearing (20,000 hertz or 20 kilohertz). Typical diagnostic sonographic scanners operate in the frequency range of 2 to 18 megahertz, hundreds of times greater than the limit of human hearing. The choice of frequency is a trade-off between spatial resolution of the image and imaging depth: lower frequencies produce less resolution but image deeper into the body.

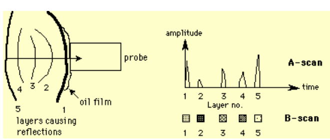
Contents [hide]

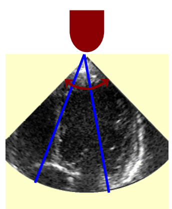
A fetus in the womb, viewed in a sonogram

USG

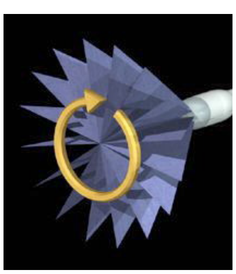


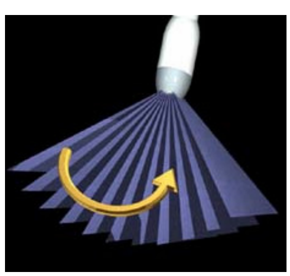
- ultrasound
- reflection
- time

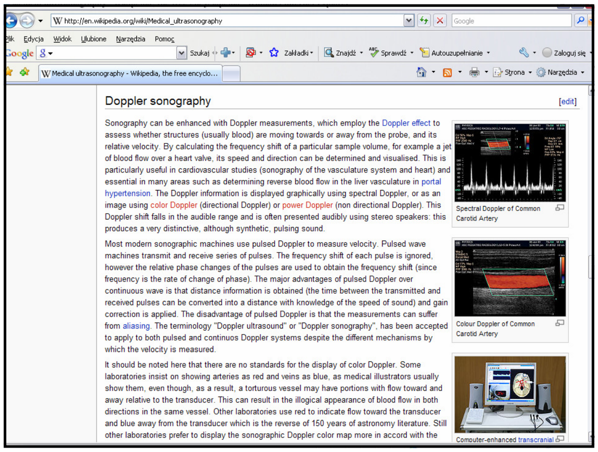




USG 3D







http://en.wikipedia.org/wiki/Medical_ultrasonography

Medical ultrasonography - Wikipedia, the free encyclo...

Doppler sonography [edit]

Sonography can be enhanced with Doppler measurements, which employ the Doppler effect to assess whether structures (usually blood) are moving towards or away from the probe, and its relative velocity. By calculating the frequency shift of a particular sample volume, for example a jet of blood flow over a heart valve, its speed and direction can be determined and visualised. This is particularly useful in cardiovascular studies (sonography of the vasculature system and heart) and essential in many areas such as determining reverse blood flow in the liver vasculature in portal hypertension. The Doppler information is displayed graphically using spectral Doppler, or as an image using color Doppler (directional Doppler) or power Doppler (non directional Doppler). This Doppler shift falls in the audible range and is often presented audibly using stereo speakers: this produces a very distinctive, although synthetic, pulsing sound.

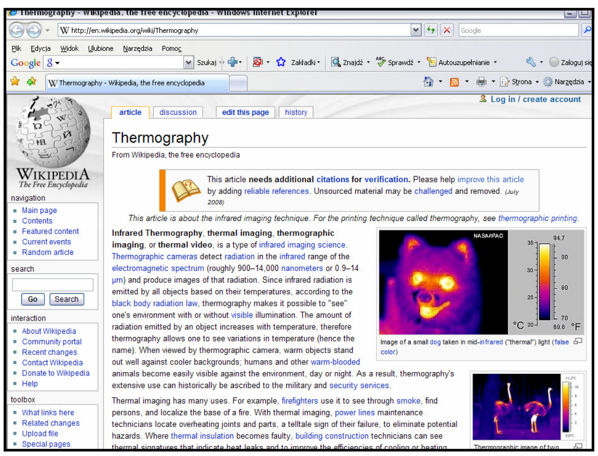
Spectral Doppler of Common Carotid Artery

Most modern sonographic machines use pulsed Doppler to measure velocity. Pulsed wave machines transmit and receive series of pulses. The frequency shift of each pulse is ignored, however the relative phase changes of the pulses are used to obtain the frequency shift (since frequency is the rate of change of phase). The major advantages of pulsed Doppler over continuous wave is that distance information is obtained (the time between the transmitted and received pulses can be converted into a distance with knowledge of the speed of sound) and gain correction is applied. The disadvantage of pulsed Doppler is that the measurements can suffer from aliasing. The terminology "Doppler ultrasound" or "Doppler sonography", has been accepted to apply to both pulsed and continuos Doppler systems despite the different mechanisms by which the velocity is measured.

Colour Doppler of Common Carotid Artery

It should be noted here that there are no standards for the display of color Doppler. Some laboratories insist on showing arteries as red and veins as blue, as medical illustrators usually show them, even though, as a result, a torturous vessel may have portions with flow toward and away relative to the transducer. This can result in the illogical appearance of blood flow in both directions in the same vessel. Other laboratories use red to indicate flow toward the transducer and blue away from the transducer which is the reverse of 150 years of astronomy literature. Still other laboratories prefer to display the sonographic Doppler color map more in accord with the

Computer-enhanced transcranial



Thermography - Wikipedia, the free encyclopedia - Windows Internet Explorer

http://en.wikipedia.org/wiki/Thermography

navigation: Main page, Contents, Featured content, Current events, Random article

search: Go, Search

interaction: About Wikipedia, Community portal, Recent changes, Contact Wikipedia, Donate to Wikipedia, Help

toolbox: What links here, Related changes, Upload file, Special pages

article | discussion | edit this page | history — Log in / create account

Thermography

From Wikipedia, the free encyclopedia

This article **needs additional citations for verification.** Please help improve this article by adding reliable references. Unsourced material may be challenged and removed. *(July 2008)*

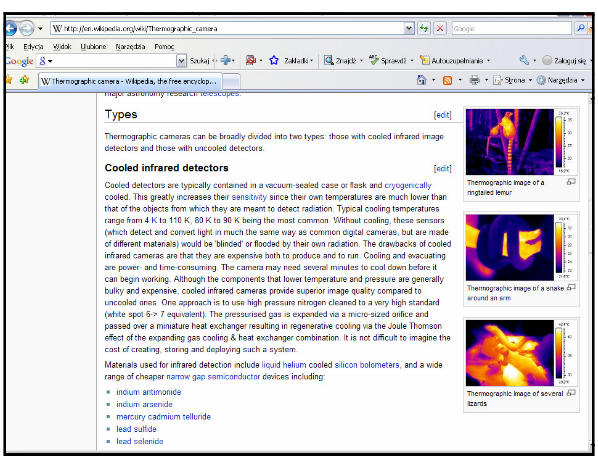
This article is about the infrared imaging technique. For the printing technique called thermography, see thermographic printing.

Infrared Thermography, **thermal imaging**, **thermographic imaging**, or **thermal video**, is a type of infrared imaging science. Thermographic cameras detect radiation in the infrared range of the electromagnetic spectrum (roughly 900–14,000 nanometers or 0.9–14 µm) and produce images of that radiation. Since infrared radiation is emitted by all objects based on their temperatures, according to the black body radiation law, thermography makes it possible to "see" one's environment with or without visible illumination. The amount of radiation emitted by an object increases with temperature, therefore thermography allows one to see variations in temperature (hence the name). When viewed by thermographic camera, warm objects stand out well against cooler backgrounds; humans and other warm-blooded animals become easily visible against the environment, day or night. As a result, thermography's extensive use can historically be ascribed to the military and security services.

Image of a small dog taken in mid-infrared ("thermal") light (false color)

Thermal imaging has many uses. For example, firefighters use it to see through smoke, find persons, and localize the base of a fire. With thermal imaging, power lines maintenance technicians locate overheating joints and parts, a telltale sign of their failure, to eliminate potential hazards. Where thermal insulation becomes faulty, building construction technicians can see thermal signatures that indicate heat leaks and to improve the efficiencies of cooling or heating

Thermographic image of two



http://en.wikipedia.org/wiki/Thermographic_camera

Thermographic camera - Wikipedia, the free encyclop...

major astronomy research telescopes.

Types [edit]

Thermographic cameras can be broadly divided into two types: those with cooled infrared image detectors and those with uncooled detectors.

Cooled infrared detectors [edit]

Cooled detectors are typically contained in a vacuum-sealed case or flask and cryogenically cooled. This greatly increases their sensitivity since their own temperatures are much lower than that of the objects from which they are meant to detect radiation. Typical cooling temperatures range from 4 K to 110 K, 80 K to 90 K being the most common. Without cooling, these sensors (which detect and convert light in much the same way as common digital cameras, but are made of different materials) would be 'blinded' or flooded by their own radiation. The drawbacks of cooled infrared cameras are that they are expensive both to produce and to run. Cooling and evacuating are power- and time-consuming. The camera may need several minutes to cool down before it can begin working. Although the components that lower temperature and pressure are generally bulky and expensive, cooled infrared cameras provide superior image quality compared to uncooled ones. One approach is to use high pressure nitrogen cleaned to a very high standard (white spot 6-> 7 equivalent). The pressurised gas is expanded via a micro-sized orifice and passed over a miniature heat exchanger resulting in regenerative cooling via the Joule Thomson effect of the expanding gas cooling & heat exchanger combination. It is not difficult to imagine the cost of creating, storing and deploying such a system.

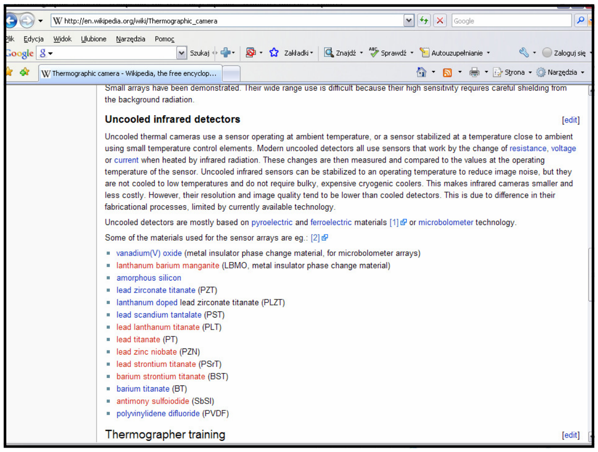
Materials used for infrared detection include liquid helium cooled silicon bolometers, and a wide range of cheaper narrow gap semiconductor devices including:

- indium antimonide
- indium arsenide
- mercury cadmium telluride
- lead sulfide
- lead selenide

Thermographic image of a ringtailed lemur

Thermographic image of a snake around an arm

Thermographic image of several lizards


Small arrays have been demonstrated. Their wide range use is difficult because their high sensitivity requires careful shielding from the background radiation.

Uncooled infrared detectors [edit]

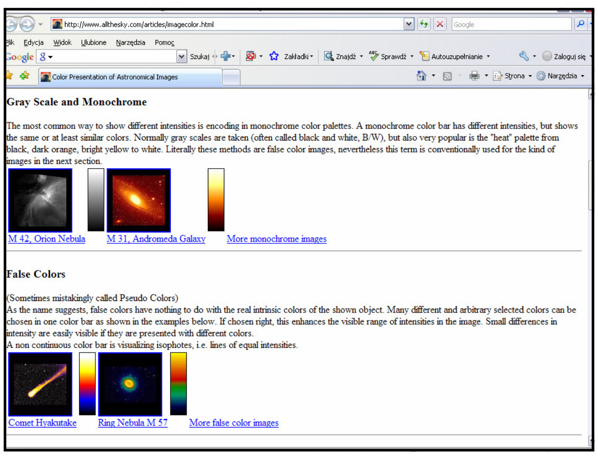
Uncooled thermal cameras use a sensor operating at ambient temperature, or a sensor stabilized at a temperature close to ambient using small temperature control elements. Modern uncooled detectors all use sensors that work by the change of resistance, voltage or current when heated by infrared radiation. These changes are then measured and compared to the values at the operating temperature of the sensor. Uncooled infrared sensors can be stabilized to an operating temperature to reduce image noise, but they are not cooled to low temperatures and do not require bulky, expensive cryogenic coolers. This makes infrared cameras smaller and less costly. However, their resolution and image quality tend to be lower than cooled detectors. This is due to difference in their fabricational processes, limited by currently available technology.

Uncooled detectors are mostly based on pyroelectric and ferroelectric materials [1] or microbolometer technology.

Some of the materials used for the sensor arrays are eg.: [2]

- vanadium(V) oxide (metal insulator phase change material, for microbolometer arrays)
- lanthanum barium manganite (LBMO, metal insulator phase change material)
- amorphous silicon
- lead zirconate titanate (PZT)
- lanthanum doped lead zirconate titanate (PLZT)
- lead scandium tantalate (PST)
- lead lanthanum titanate (PLT)
- lead titanate (PT)
- lead zinc niobate (PZN)
- lead strontium titanate (PSrT)
- barium strontium titanate (BST)
- barium titanate (BT)
- antimony sulfoiodide (SbSI)
- polyvinylidene difluoride (PVDF)

Thermographer training [edit]


Gray Scale and Monochrome

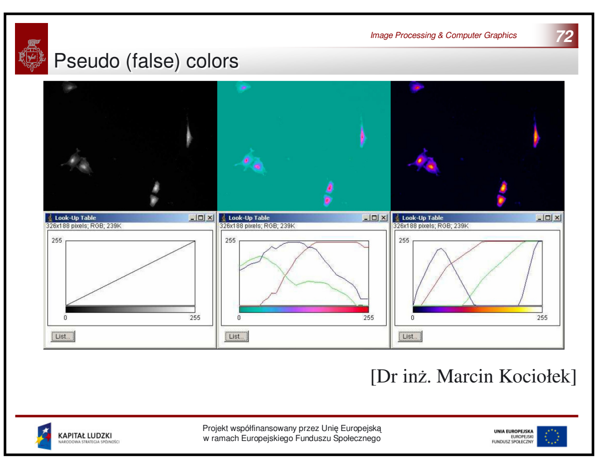
The most common way to show different intensities is encoding in monochrome color palettes. A monochrome color bar has different intensities, but shows the same or at least similar colors. Normally gray scales are taken (often called black and white, B/W), but also very popular is the "heat" palette from black, dark orange, bright yellow to white. Literally these methods are false color images, nevertheless this term is conventionally used for the kind of images in the next section.

M 42, Orion Nebula — M 31, Andromeda Galaxy — More monochrome images

False Colors

(Sometimes mistakingly called Pseudo Colors)
As the name suggests, false colors have nothing to do with the real intrinsic colors of the shown object. Many different and arbitrary selected colors can be chosen in one color bar as shown in the examples below. If chosen right, this enhances the visible range of intensities in the image. Small differences in intensity are easily visible if they are presented with different colors.
A non continuous color bar is visualizing isophotes, i.e. lines of equal intensities.

Comet Hyakutake — Ring Nebula M 57 — More false color images



Summary, discussion and quiz

Summary, discussion and quiz

KAPITAŁ LUDZKI
NARODOWA STRATEGIA SPÓJNOŚCI
Projekt współfinansowany przez Unię Europejską
w ramach Europejskiego Funduszu Społecznego
UNIA EUROPEJSKA
EUROPEJSKI
FUNDUSZ SPOŁECZNY

KAPITAŁ LUDZKI
NARODOWA STRATEGIA SPÓJNOŚCI
UNIA EUROPEJSKA
EUROPEJSKI
FUNDUSZ SPOŁECZNY

„ Image Processing and Computer Graphics"

**Prezentacja multimedialna współfinansowana przez
Unię Europejską w ramach
Europejskiego Funduszu Społecznego w projekcie pt.**
„*Innowacyjna dydaktyka bez ograniczeń - zintegrowany rozwój Politechniki Łódzkiej - zarządzanie Uczelnią, nowoczesna oferta edukacyjna i wzmacniania zdolności do zatrudniania osób niepełnosprawnych*"

Politechnika Łódzka
Politechnika Łódzka, ul. Żeromskiego 116, 90-924 Łódź, tel. (042) 631 28 83
www.kapitalludzki.p.lodz.pl