AVT Glossary

4:1:1

YUV4:1:1 is a color mode (see YUV).

Chroma subsampling means that a lower resolution for the color (chroma) information in an image is used than for the brightness (intensity or luma) information.

Because the human eye is less sensitive to color than intensity, the chroma components of an image need not be as well defined as the luma component, so many video systems sample the color difference channels at a lower definition (i.e., sample frequency) than the brightness. This reduces the overall bandwidth of the video signal without much apparent loss of picture quality. The missing values will be interpolated or repeated from the preceding sample for that channel.

Sampling systems and ratios: The subsampling in a video system is usually expressed as a three part ratio. The three terms of the ratio are: the number of brightness (luma or Y) samples, followed by the number of samples of the two color (chroma) components: U then V, for each complete sample area. For quality comparison, only the ratio between those values is important, so 4:4:4 could easily be called 1:1:1; however, traditionally the value for brightness is always 4, with the rest of the values scaled accordingly.

YUV4:1:1 means: chroma subsampling, the horizontal color resolution is quartered. This is still acceptable for lower-end and consumer applications. Uncompressed video in this format with 8-bit quantization uses 6 bytes for every macropixel (4 pixels in a row).

4:2:2

YUV4:2:2 is a color mode (see YUV).

For detailed explanation of chroma subsampling see 4:1:1.

In YUV4:2:2 color mode each of the two color-difference channels has half the sample rate of the brightness channel, so horizontal color resolution is only half that of 4:4:4.

ADC

ADC = **a**nalog **d**igital **c**onverter

An analog-to-digital converter (abbreviated ADC, A/D, or A to D) is a device that converts continuous signals to discrete digital numbers.

Typically, an ADC converts a voltage to a digital number. A digital-to-analog converter (DAC) performs the reverse operation.

AEC

AEC = **a**uto **e**xposure **c**ontrol

AFE

AFE = **a**nalog **f**ront **e**nd

The AFE conditions the analog signal received from the image sensor and performs the analog-to-digital (A/D) conversion.

AGC

AGC = **a**uto **g**ain **c**ontrol

AGC means that the electronic amplification of the video signal is automatically adjusted to compensate for varying levels of scene illumination.

Aliasing

Phenomenon of interference which occurs when a signal being sampled contains frequencies that are higher than half the sampling frequency. Typically can be seen as ragged edges on horizontal lines.

Analog front end

see AFE

AOI

AOI = **a**rea **o**f **i**nterest

see area of interest

Area of interest

Area of interest readout (AOI) refers to a camera function whereby only a portion of the available pixels are read out from the camera. For example, it is possible to read out a 10 x 20 pixel rectangular area of pixels from a camera that has a total resolution of 648 x 488. The result is a much faster frame rate and less data to be processed. This is also referred to as partial scan. Various autofunctions (auto shutter, auto gain, auto white balance) act on the AOI.

Asynchronous shutter

The camera CCD starts to accumulate electrons on receipt of an external trigger pulse.

Asynchronous transmission mode

Asynchronous transmission mode is a mode supported by IEEE 1394 (FireWire). IEEE 1394 supports asynchronous data transmission, which includes receipt datagrams that indicate that the data was transmitted reliably to the 1394 device. Asynchronous data transfers place emphasis on delivery rather than timing. The data transmission is guaranteed, and retries are supported. An example for an asynchronous transmission mode is the one-shot comand. All cameras receive the one-shot command in the same IEEE 1394 bus cycle. This creates uncertainty for all cameras in the range of 125 µs.

AWB

AWB = **a**uto **w**hite **b**alance

A system for automatically setting the white balance in digital cameras.

see white balance

Bayer, Dr. Bryce E.

Dr. Bryce E. Bayer (Eastman Kodak) is the inventor of the so-called BAYER patent (20 July 1976).

BAYER

Patent of Dr. Bryce E. Bayer of Eastman Kodak. This patent refers to a particular arrangement of color filters used in most single-chip digital image sensors used in digital cameras to create a color image. The filter pattern is 50% green, 25% red and 25% blue, hence is also called RGBG or GRGB

BAYER demosaicing

BAYER demosaicing is the process of transforming the BAYER mosaic back to RGB.

BAYER filter

see BAYER mosaic

BAYER mosaic

A Bayer filter mosaic is a color filter array (CFA) for arranging RGB color filters on a square grid of photo sensors. The term derives from the name of its inventor, Bryce Bayer of Eastman Kodak, and refers to a particular arrangement of color filters used in most single-chip digital cameras.

Bryce Bayer's patent called the green photo sensors luma-sensitive elements and the red and blue ones chrominance-sensitive elements. He used twice as many green elements as red or blue to mimic the human eye's greater resolving power with green light. These elements are referred to as samples and after interpolation become pixels.

The raw output of Bayer-filter cameras is referred to as a Bayer Pattern image. Since each pixel is filtered to record only one of the three colors, two-thirds of the color data is missing from each. A demosaicing algorithm is used to interpolate a set of complete red, green, and blue values for each point, to make an RGB image. Many different algorithms exist.

Big endian

Byte order: big units first (compare: little endian)

Bilingual connector

Beside the GOF connector PIKE cameras have the bilingual connector. This is a copper connection, which is able to *speak* 1394a & 1394b.

Binning

Binning is the process of combining neighboring pixels while being read out from the CCD chip.

Binning factor

Binning factor is the number of pixels to be combined on a CCD during binning. A binning factor of 2x2 means that the pixels in two rows and two columns (a total of four pixels) are combined for CCD readout.

Bit depth

Bit depth is the number of bits that are digitized by the A/D converter.

Bitmap

A raster graphics image, digital image, or bitmap, is a data file or structure representing a generally rectangular grid of pixels, or points of color, on a computer monitor, paper, or other display device.

Blooming

A pixel on a digital camera sensor collects photons which are converted into an electrical charge by its photo diode. Once the full well capacity of the pixel is full, the charge caused by additional photons will overflow and have no effect on the pixel value, resulting in a clipped or overexposed pixel value. Blooming occurs when this charge flows over to surrounding pixels, brightening or overexposing them in the process. As a result detail is lost. Blooming can also increase the visibility of purple fringing.

BMP bitmap

The BMP (bit mapped) format is used internally in the Microsoft Windows operating system to handle graphics images. These files are typically not compressed resulting in large files. The main advantage of BMP files is their wide acceptance and use in Windows programs. Their large size makes them unsuitable for file transfer. Desktop backgrounds and images from scanners are usually stored in BMP files.

CCD

charge-**c**oupled **d**evice

CCD readout

CCDs are analog devices. In order to obtain a digital signal that is appropriate for doing quantitative analysis, it is necessary to convert the analog signal to a digital format. When light is gathered on a CCD and is ready to be read out, a series of serial shifts and parallel shifts occurs. First, the rows are shifted in the serial direction towards the serial register. Once in the serial register, the data is shifted in the parallel direction out of the serial register, into the output node, and then into the A/D converter where the analog data is converted into a digital signal.

CDS

CDS = **c**orrelated **d**ouble **s**ampling

Charge-coupled device

A charge-coupled device (CCD) is a sensor for recording images, consisting of an integrated circuit containing an array of linked, or coupled, capacitors. Under the control of an external circuit, each capacitor can transfer its electric charge to one or other of its neighbors. CCDs are used in digital cameras and are manufactured in a wide variety of formats, architectures, and grades.

CMOS

CMOS (pronounced *see-moss*) stands for **c**omplementary **m**etal-**o**xide **s**emiconductor

CMOS is a major class of integrated circuits. CMOS chips include microprocessor, microcontroller, static RAM, and other digital logic circuits. The central characteristic of the technology is that it only uses significant power when its transistors are switching between on and off states. Consequently, CMOS devices use little power and do not produce as much heat as other forms of logic. CMOS also allows a high density of logic functions on a chip.

CMOS image sensors also allow processing circuits to be included on the same chip, an advantage not possible with CCD sensors, which are also much more expensive to produce.

C-Mount

A standard lens interface used on digital cameras. It is a 1 inch diameter, 32 tpi (=threads per inch) interface with a flange-to-image plane distance of 17.526 mm.

Color aliasing

Color aliasing is caused by the color filters on a single CCD camera. A small white line on a black background that registers on individual pixels in a CCD will be interpreted as a line containing single pixels of each of the primary colors registered.

Color reproduction

Color reproduction is the process to reproduce colors on different devices. Two common methods used for reproducing color are additive color mixtures and subtractive color mixtures.

Correlated double sampling

abbr. CDS

Correlated double sampling is a sampling technique used to achieve higher precision in CCD readout. The sampling circuit is reset to a predetermined reference level and then the actual pixel voltage is sampled in order to find the difference between the two. Using the resulting correlation minimizes read noise, especially in ultra-low-noise cameras.

CS-Mount

A relatively new industry standard used on digital cameras. It is a 1 inch diameter, 32 tpi (=threads per inch) interface with a flange-to-image plane distance of 12.526 mm.

CSR

CSR = **C**amera_**S**tatus_**R**egister

CSR architecture

A convenient abbreviation of the following reference:

ISO/IEC 13213 : 1994 [ANSI/IEEE Std 1212, 1994 Edition], Information Technology — Microprocessor systems — Control and Status Register (CSR) Architecture for Microcomputer Buses.

Dark current

Dark current is the accumulation of electrons within a CCD or CMOS image sensor that are generated thermally rather than by light. This is a form of noise that is most problematic in low light applications requiring long exposure times.

Dark noise

Dark noise is the statistical variation of the dark current, equal to the square root of the dark current. Dark current can be subtracted from an image, while dark noise remains. Also called dark current noise.

dB

abbr. of decibel

see decibel

DCAM

DCAM = **d**igital **cam**era **s**pecification

DCAM or IIDC is a software interface standard for communicating with cameras over FireWire. It is a standardized set of registers etc. If a camera is DCAM compliant then its control registers and data structures comply with the DCAM spec. Such a camera can be truly plug & play in a way that other cameras are not. Recent specifications are IIDC V1.30 and IIDC V1.31.

Decibel

Decibel (abbr. dB) is a measurement unit of dynamic range.

Depth of field

Depth of field refers to the in-focus region of an imaging system. When using a lens, especially in close proximity, objects at and near a certain distance will be in focus whereas other objects in the field of view that are closer or farther away will appear fuzzy, or out of focus. The depth of the region that appears in focus is called the depth of field. Generally speaking, the depth of field will be large if the lens aperture is small (large f-number), and the depth of field will be small with a wide aperture (small f-number).

Digital camera

A digital camera is an electronic device to transform images into electronic data. Modern digital cameras are typically multifunctional and the same device can take photographs, video, and/or sound.

Digital photography

Digital photography uses an electronic sensor to record the image as a piece of electronic data.

There are two main types of sensors:

- charge-coupled device (CCD)
- CMOS semiconductor

There are also two main types of sensor mechanisms:

- Area array
- Linear array (very rare, only limited to the highest-end)

An area array sensor reads the entire image plane at once, whereas a linear array sensor works more like a flatbed scanner.

Dynamic range

The ratio of the maximum signal relative to the minimum measurable signal often measured in decibels or dBs.

The largest possible signal is directly proportional to the full well capacity of the pixel. The lowest signal is the noise level when the sensor is not exposed to any light, also called the noise floor.

Practically, cameras with a large dynamic range are able to capture shadow detail and highlight detail at the same time. Dynamic range should not be confused with tonal range.

Exposure time

Exposure time is the amount of time that the sensor is exposed to the light and thus accumulates charge. This is the control that is used first (before gain and offset) to adjust the camera.

Field of view

Field of view (FOV) is the area covered by the lens' angle of view.

FireWire

FireWire (also known as i.Link or IEEE 1394) is a personal computer (and digital audio/video) serial bus interface standard, offering high-speed communications. It is often used as an interface for industrial cameras.

Fixed pattern noise

abbr. **FPN**

If the output of an image sensor under no illumination is viewed at high gain a distinct non-uniform pattern, or fixed pattern noise, can be seen. This fixed pattern can be removed from the video by subtracting the dark value of each pixel from the pixel values read out in all subsequent frames.

Dark fixed pattern noise is usually caused by variations in dark current across an imager, but can also be caused by input clocking signals abruptly starting or stopping or if the CCD clocks do not closely match one another.

Mismatched CCD clocks can result in high instantaneous substrate currents, which, when combined with the fact that the silicon substrate has some non-zero resistance, can cause in the substrate potential bouncing.

The pattern noise can also be seen when the imager is under uniform illumination. An imager which exhibits a fixed pattern noise under uniform illumination and shows no pattern in the dark is said to have **light pattern noise** or **photosensitivity pattern noise**. In addition to the reasons mentioned above, light pattern noise can be caused by the imager becoming saturated, the non-uniform clipping effect of the anti-blooming circuit, and by non-uniform, photosensitive pixel areas often caused by debris covering portions of some pixels.

FOV

FOV = **f**ield **o**f **v**iew

see field of view

FPN

FPN = **f**ixed **p**attern **n**oise

Related with the dark current is its electrical behavior to be regionally different on the sensor. This introduces a structural spatial noise component, called fixed pattern noise, although it's not meant temporal, visible with low illumination conditions.

FPN is typically more dominant with CMOS sensors than with CCD, where it can be ignored mostly.

This noise nfpn [%] is usually quantified in % of the mean dark level.

Frame

An individual picture image taken by a digital camera. Using an interlaced camera, a frame consists of 2 interlaces fields.

Frame grabber

A component of a computer system designed for digitizing analog video signals.

Frame rate

Frame rate is the measure of camera speed. The unit of this measurement is **frames per second** (fps) and is the number of images a camera can capture in a second of time. Using area of interest (AOI) readout, the frame rate can be increased.

Full binning

If horizontal and vertical binning are combined, every 4 pixels are consolidated into a single pixel. At first, two horizontal pixels are put together and then combined vertically.

This increases light sensitivity by a total of a factor of 4 and at the same time signal-to-noise separation is improved by about 6 dB. Resolution is reduced, depending on the model.

See also: horizontal binning and vertical binning

Gain

Gain is the same as the contrast control on your TV. It is a multiplication of the signal. In math terms, it controls the slope of the exposure/time curve. The camera should normally be operated at the lowest gain possible, because gain not only multiplies the signal, but also multiplies the noise. Gain comes in very handy when you require a short exposure (say, because the object is moving and you do not want any blur), but do not have adequate lighting. In this situation the gain can be increased so that the image signal is strong.

Gamma

Gamma is the exponent in a power-law relationship between video or pixel values and the displayed brightness.

Each pixel in a digital image has a certain level of brightness ranging from black (0) to white (1). These pixel values serve as the input for your computer monitor. Due to technical limitations, CRT monitors output these values in a nonlinear way:

$$\text{Output} = \text{Input}^{\text{gamma}}$$

When unadjusted, most CRT monitors have a gamma of 2.5 which means that pixels with a brightness of 0.5, will be displayed with a brightness of only $0.5^{2.5} = 0.18$ in non-colormanaged applications. LCDs, in particular those on notebooks, tend to have rather irregularly shaped output curves. Calibration via software and/or hardware ensures that the monitor outputs the image based on a predetermined gamma curve, typically 2.2 for Windows, which is approximately the inverse of the response of the human vision. The sRGB and Adobe RGB color spaces are also based on a gamma of 2.2.

A monitor with a gamma equal to 1.0 would respond in a linear way (Output = Input) and images created on a system with a gamma of 2.2 would appear flat and overly bright in non-color managed applications.

GIF

GIF = **G**raphics **I**nterchange **F**ormat

GIF is one of the most common file formats used for images in web pages. There are two versions of the format, 87a and 89a. Version 89a supports animations, i.e. a short sequence of images within a single GIF file. A GIF89a can also be specified for interlaced presentation.

Gigabit Ethernet

Gigabit Ethernet is an industry standard interface used for high-speed computer networks that is now being adapted as a camera interface. This generalized networking interface is being adapted for use as a standard interface for high-performance machine vision cameras that is called GigE Vision.

GigE Vision

GigE Vision is a new interface standard, published by the AIA, for high-performance machine vision cameras. GigE (Gigabit Ethernet), on the other hand, is simply the network structure on which GiGE Vision is built. The GigE Vision standard includes both a hardware interface standard (Gigabit Ethernet), communications protocols, and standardized camera control registers. The camera control registers are based on a command structure called GenICam. GenICam seeks to establish a common software interface so that third party software can communicate with cameras from various manufacturers without customization. GenICam is incorporated as part of the GigE Vision standard. GigE Vision is analogous to FireWire's DCAM, or IIDC interface standard and has great value for reducing camera system integration costs and for improving ease of use.

Global pipelined shutter

A global pipelined shutter assures that the integration for all pixels starts and stops at the same moment in time. The integration of the next image is possible during the readout of the previously captured image.

Global shutter

All pixels are exposed to the light at the same moment and for the same time span.

GOF

GOF connection is a glass fiber connection that conforms to 1394b. The advantage of this is the galvanic disconnection between the camera and the PC (e.g. for medical purposes) and the enhanced cable distance (up to 500 m, with GOF "only" in the range of up to 20 m).

Beside the optional GOF port in the (PIKE) camera, AVT offers 1394b cards with GOF interface for a point-to-point connection between the camera and the PC.

Beside the GOF connector PIKE cameras have the bilingual connector. This is a copper connection, which is able to "speak" 1394a & 1394b.

HDR mode

HDR = **h**igh **d**ynamic **r**ange

High dynamic range

In the high dynamic range mode various nonlinearity points, the so-called knee-points (and integration time as a second parameter) can be freely adjusted, leading to increased dynamic range. This enables the high dynamic range of the sensor to be compressed into 8 bit, preserving interesting details of the image. This mode is also known as multiple slope.

Horizontal binning

In **horizontal binning** adjacent horizontal pixels in a line are combined in pairs.

This means that in horizontal binning the light sensitivity of the camera is also increased by a factor of two (6 dB). Signal-to-noise separation improves by approx. 3 dB. Horizontal resolution is lowered, depending on the model.

See also: vertical binning and full binning

Host computer

Host computer is the primary or controlling computer for a digital camera.

HSV color space

The HSV (hue, saturation, value) model, also called HSB (hue, saturation, brightness), defines a color space in terms of three constituent components:

- Hue, the color type (such as red, blue, or yellow)
- Saturation, the vibrancy of the color and colorimetric purity
- Value, the brightness of the color

Hue

A hue refers to the gradation of color within the optical spectrum, or visible spectrum, of light. Hue may also refer to a particular color within this spectrum, as defined by its dominant wavelength, or the central tendency of its combined wavelengths. For example, a light wave with a central tendency within 565-590 nm will be yellow.

In an RGB color space, hue can be thought of as an angle φ in standard position. The other coordinates are saturation and brightness.

IEEE

The **I**nstitute of **E**lectrical and **E**lectronics **E**ngineers, Inc.

IEEE 1394 Trade Association

IEEE 1394 Trade Association is a non-profit industry association devoted to the promotion of and growth of the market for IEEE 1394-compliant products.

Participants in working groups serve voluntarily and without compensation from the Trade Association. Most participants represent member organizations of the 1394 Trade Association. The specifications developed within the working groups represent a consensus of the expertise represented by the participants.

Background of the Trade Association and IEEE 1394

The 1394 Trade Association was founded in 1994 to support the development of computer and consumer electronics systems that can be easily connected with each other via a single serial multimedia link. The IEEE 1394 multimedia connection enables simple, low cost, high bandwidth isochronous (real time) data interfacing between computers, peripherals, and consumer electronics products such as camcorders, VCRs, printers, PCs, TVs, and digital cameras. With IEEE 1394 compatible products and systems, users can transfer video or still images from a camera or camcorder to a printer, PC, or television, with no image degradation. The 1394 Trade Association includes more than 170 companies and continues to grow.

Members of the 1394 Trade Association

The 1394 Trade Association is comprised of more than 170 member companies. Membership is still in a rapid growth phase, with approximately one company a week joining the 1394 TA. The membership consists of a number of companies of every size in almost every sector of the electronics industry. Some of the best known names in the 1394 TA membership are Sony, Intel, Microsoft, JVC, Matsushita, Compaq, NEC, Philips, Samsung, among other well respected electronics institutions.

Organization of the 1394 Trade Association

The 1394 TA is incorporated as a nonprofit trade organization. Its Board of Directors and Chair are volunteers elected from the membership of the association. The 1394 TA maintains an office in Southlake, Texas, with paid staff that execute the programs organized by the 1394 TA membership.

IIDC

The 1394 Trade Association **I**nstrumentation and **I**ndustrial Control Working Group, **D**igital **C**amera Sub Working Group

IIDC V1.3

IIDC V1.3

IIDC 1394-based Digital Camera Specification Version 1.30 July 25, 2000

The purpose of this document is to act as a design guide for digital camera makers that wish to use IEEE 1394 as the camera-to-PC interconnect. Adherence to the design specifications contained herein do not guarantee, but will promote interoperability for this class of device. The camera registers, fields within those registers, video formats, modes of operation, and controls for each are specified. Area has been left for growth. To make application for additional specification, contact the 1394 Trade Association Instrumentation and Industrial Control Working Group, Digital Camera Sub Working Group (II-WG DC-SWG).

http://www.1394ta.org/Technology/Specifications/

IIDC V1.31

IIDC V1.31 was published in January 2004, evolving the industry standards for digital imaging communications to include I/O and RS232 handling, and adding additional formats.

Image processing

In the broadest sense, image processing includes any form of information processing in which the input is an image. Many image processing techniques derive from the application of signal processing techniques to the domain of images — two-dimensional signals such as photographs or video.

Typical problems are:

- Geometric transformations such as enlargement, reduction, and rotation
- Color corrections such as brightness and contrast adjustments, quantization, or conversion to a different color space
- Combination of two or more images, e.g. into an average, blend, difference, or image composite
- Interpolation, demosaicing, and recovery of a full image from a mosaic image (e.g. a Bayer pattern, etc.)
- Noise reduction and other types of filtering, and signal averaging
- Edge detection and other local operators
- Segmentation of the image into regions

Infrared

Infrared (abbr. IR) is the region beyond the visible spectrum at the red end, typically greater than 770 nm.

see IR cut filter

Interline transfer CCD

Interline transfer CCD or just interline CCD is a type of CCD in which the parallel register is subdivided so that, like a Venetian blind, opaque strips span and mask the columns of pixels. The masks act as storage areas. When the CCD is exposed to light, the image accumulates in the exposed areas (photosites) of the parallel register. In the serial register, the entire image is under the interline mask when it shifts for CCD readout. It is possible to shift the integrated charge quickly (200 ns) under the storage areas. Since these devices function as a fast shutter (or gate), they are also sometimes referred to as gated interline CCDs.

See microlens

IR

IR = infrared

IR cut filter

As color cameras can see infrared radiation as well as visible light, these cameras are usually equipped with an IR cut filter, to prevent distortion of the colors the human eye can see. To use the camera in very dark locations or at night, this filter can be removed, to allow infrared radiation to hit the image sensor and thus produce images.

Isochronous transmission mode

Isochronous transmission mode is a mode supported by IEEE 1394 (FireWire). IEEE 1394 supports a guaranteed data path bandwidth and allows for real-time transmission of data to/from 1394 devices. Isochronous data transfers operate in a broadcast manner, where one or many 1394 devices can listen to the data being transmitted. The emphasis of isochronous data transfers is placed on guaranteed data timing rather than guaranteed delivery. Multiple channels (up to 16) of isochronous data can be transferred simultaneously on the 1394 bus. Since isochronous transfers can only take up a maximum of 80 percent of the 1394 bus bandwidth, there is enough bandwidth left over for additional asynchronous transfers.

(See also Asynchronous transmission mode).

Jitter

Small, rapid variations in a waveform due to mechanical disturbances or to changes in the characteristic of components. They are caused by variations in supply voltages, imperfect synchronizing signals, circuits, etc.

JPEG, JPG

The JPEG (**J**oint **P**hotographic **E**xperts **G**roup) image files are files in a lossy format. The DOS filename extension is JPG, although other operating systems may use JPEG. Nearly all digital cameras have the option to save images in JPEG format, some at different compression levels, such as fine and standard. The JPEG format supports full color and produces relatively small file sizes. Fortunately, the compression in most cases does not detract noticeably from the image. But JPEG files do suffer generational degradation when repeatedly edited and saved. Photographic images are best stored in a lossless non-JPEG format if they will be re-edited in future, or if the presence of small artifacts (blemishes), due to the nature of the JPEG compression algorithm, is unacceptable. JPEG is also used as the image compression algorithm in many Adobe PDF files.

Linux

Linux is an open source Unix-like operating system. Because of its robustness and availability, Linux has won popularity in the open source community and among commercial application developers.

Little endian

Byte order: little units first (compare: big endian)

Lux

The **lux** (symbol: lx) is the SI unit of illuminance. It is used in photometry as a measure of the intensity of light, with wavelengths weighted according to the luminosity function, a standardized model of human brightness perception. In English, **lux** is used in both singular and plural.

Machine vision

Machine vision is the application of cameras and computers to cause some automated action based on images received by the camera(s) in a manufacturing process. Generally, the term **machine vision** applies specifically to manufacturing applications and has an automated aspect related to the vision sensors. However, it is common to use machine vision equipment and algorithm outside of the manufacturing realm.

Megapixel

Megapixel refers to one million pixels - relating to the spatial resolution of a camera. Any camera that is roughly 1000 x 1000 or higher resolution would be called a megapixel camera.

Microlens

Microlens is a type of technology used in some interline transfer CCDs whereby each pixel is covered by a small lens which channels light directly into the sensitive portion of the CCD.

OCR

OCR = **O**ptical **C**haracter **R**ecognition

Offset

Offset is just the same as the brightness control on your TV. It is a positive DC offset of the image signal. It is used primarily to set the level of black. Generally speaking, for the best signal, the black level should be set so that it is near zero (but not below zero) on the histogram. Increasing the brightness beyond this point just lightens the image but without improving the image data.

OHCI

OHCI = **O**pen **H**ost **C**ontroller **I**nterface

One-push autofocus

Focus hold mode that can be automatically readjusted as required by the user (one-push autofocus trigger) assuming that the required subject is within the focusing limits of the camera lens.

One-push white balance

AVT color cameras have not only manual but also one-push white balance.

For white balance, in total a number of frames are processed and a grid of a number of samples is equally spread over the whole image area.

The R-G-B component values of the samples are added and are used as actual values for both the one-push and the automatic white balance.

This feature uses the assumption that the R-G-B component sums of the samples are equal; i.e., it assumes that the average of the sampled grid pixels is to be monochrome.

Opaque mask

In CCD imaging technology, a light-impenetrable material that is used to shield selected parts of a photosensitive surface. Opaque masks are used in interline transfer CCDs and frame transfer CCDs.

Open Host Controller Interface

Open Host Controller Interface (OHCI) describes the standards created by software and hardware industry leaders (including Microsoft, Apple, Compaq, Intel, Sun Microsystems, National Semiconductor, and Texas Instruments) to assure that software (operating systems, drivers, applications) works properly with any compliant hardware.

Optical Character Recognition

Optical Character Recognition (OCR) refers to the use of machine vision cameras and computers to read and analyze human-readable alphanumeric characters to recognize them.

Optocoupler

An optocoupler is a device that uses a short optical transmission path to transfer a signal between elements of a circuit, typically a transmitter and a receiver, while keeping them electrically isolated. Advantage: Since the signal goes from an electrical signal to an optical signal back to an electrical signal, electrical contact along the path is broken.

PCI Express

PCI Express (PCIE) is the next generation bus architecture and is compatible with the current PCI software environment while offering low-cost with scalable performance for the next generation of computing and communications platforms. PCIE is a serial technology with point-to-point connection to provide 2.5 Gbit/s per lane which is 2 times faster than current PCI technology. PCIE is scalable to form multiple lanes like x1, x2, x4, x8, x16, and x32.

http://www.pcisig.com

PDF

Portable **D**ocument **F**ormat

PxGA

Pixel **G**ain **A**mplifier

Pixel

Pixels are generally thought of as the smallest complete sample of an image. The definition is highly context sensitive. For example, we can speak of pixels in a visible image (e.g. a printed page) or pixels carried by one or more electronic signal(s), or represented by one or more digital value(s), or pixels on a display device, or pixels in a digital camera (photosensor elements). This list is not exhaustive and depending on context there are several synonyms which are accurate in particular contexts, e.g. pel, sample, bytes, bits, dots, spots, superset, triad, stripe set, window, etc. We can also speak of pixels in the abstract, in particular when using pixels as a measure of resolution, e.g. 2400 pixels per inch or 640 pixels per line. Dots is often used to mean pixels, especially by computer sales and marketing people, and gives rise to the abbreviation DPI or dots per inch.

The more pixels used to represent an image, the closer the result can resemble the original. The number of pixels in an image is sometimes called the resolution, though resolution has a more specific definition. Pixels can be expressed as a single number, as in a *three-megapixel* digital camera, which has a nominal three million pixels, or as a pair of numbers, as in a *640 by 480 display*, which has 640 pixels from side to side and 480 from top to bottom (as in a VGA display), and therefore has a total number of 640 × 480 = 307,200 pixels.

The color samples that form a digitized image (such as a JPG file used on a web page) are also called pixels. Depending on how a computer displays an image, these may not be in one-to-one correspondence with screen pixels. In areas where the distinction is important, the dots in the image file may be called texels.

In computer programming, an image composed of pixels is known as a bitmapped image or a raster image. The word raster originates from analogue television technology. Bitmapped images are used to encode digital video and to produce computer-generated art.

QE

QE = **q**uantum **e**fficiency

Quadlet

Four bytes of data

Quantum efficiency

Quantum efficiency (abbr. QE) is the measure of the effectiveness of an imager to produce electronic charge from incident photons. Especially important to perform low-light-level imaging.

RAW

RAW is a file option available on some digital cameras. It usually uses a lossless compression and produces file sizes much smaller than the TIFF format. Unfortunately, the RAW format is not standard among all camera manufacturers and some graphic programs and image editors may not accept the RAW format. The better graphic editors can read some manufacturer's RAW formats, and some (mostly higher-end) digital cameras also support saving images in the TIFF format directly. There are also separate tools available for converting digital camera raw image format files into other formats.

Readout

Readout refers to how data is transferred from the CCD or CMOS sensor to the host computer. Readout rate is an important specification for high-resolution digital cameras. Higher readout rates mean that more images can be captured in a given length of time.

RGB

The RGB color model utilizes the additive model in which red, green, and blue light are combined in various ways to create other colors. The very idea for the model itself and the abbreviation **RGB** come from the three primary colors in additive light models.

Note that the RGB color model itself does not define what exactly is meant by **red**, **green** and **blue**, so that the same RGB values can describe noticeably different colors on different devices employing this color model. While they share a common color model, their actual color spaces can vary considerably.

Rolling shutter

Some CMOS sensors operate in **rolling shutter** mode only so that the rows start, and stop, exposing at different times. This type of shutter is not suitable for moving subjects except when using flash lighting because this time difference causes the image to smear. (see global shutter)

RS-232

RS-232 is a long-established standard that describes the physical interface and protocol for low-speed serial data communication between devices. This is the interface that e.g. a computer uses to talk to and exchange data with a digital camera.

Saturation

In color theory, saturation or purity is the intensity of a specific hue. It is based on the color's purity; a highly saturated hue has a vivid, intense color, while a less saturated hue appears more muted and grey. With no saturation at all, the hue becomes a shade of grey. Saturation is one of three coordinates in the HSL color space and the HSV color space.

The saturation of a color is determined by a combination of light intensity and how much it is distributed across the spectrum of different wavelengths. The purest color is achieved by using just one wavelength at a high intensity such as in laser light. If the intensity drops the saturation also drops.

Scalable mode

Scalable mode allows selection of an area within a full image for output.

Sensitivity

Sensitivity is a measure of how sensitive the camera sensor is to light input. Unfortunately there is no standardized method of describing sensitivity for digital CCD or CMOS cameras.

Shading

The variation of the brightness or relative illumination over the surface of an object, often caused by color variations or surface curvature.

Signal-to-noise ratio

also called **SNR**

Signal-to-noise ratio specifies the quality of a signal with regard to its reproduction of intensities. The value signifies how high the ratio of noise is in regard to the maximum wanted signal intensity expected.

The higher this value, the better the signal quality. The unit of measurement used is generally known as the decibel (dB), a logarithmic power level. 6 dB is the signal level at approximately a factor of 2.

However, the advantages of increasing signal quality are accompanied by a reduction in resolution.

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Smart camera

A term for a complete vision system contained in the camera body itself, including imaging, image processing and decision making functions. While the common smart cameras are intended just for the dedicated systems, the latest PC technology enables development of devices fully compatible with desktop PCs. This category of smart cameras thus provides a standard API and thus much wider functionality.

Smear

Smear is an undesirable artifact of CCDs that appears in the picture as a vertical streak above and below a very bright object in the scene. Smear is caused by parasitic light getting into the vertical transfer registers. It is greatly reduced by the microlens-type of CCD used in Hyper HAD and Power HAD sensors. Almost suppressed in FIT CCDs.

SNR

SNR = **s**ignal-to-**n**oise **r**atio

Square pixel

Pixels of the same x and y dimensions (pixel aperture ratio PAR = 1). In the case of rectangular (non-square) pixels (usual in TV) one must maintain the aspect ratio when measuring objects, because the dimensions of stored frames aren't equal to true dimensions; resolutions along x and y axes aren't the same. Use of square pixels solves such problems - picture elements are equally arrayed in both directions, and allow easy addressing. Thus aspect ratio of the image does not require adjustment. This is needed in image processing tasks requiring accurate image measuring.

Aspect ratio: The ratio of horizontal to vertical dimension of the illuminated sensing area.

Pixel aperture dimension ratio: Defines the pixel dimension (the ratio of its width to height). This parameter describes the resolution (granularity) and the reproduction behavior of an image sensor area.

Aspect ratio deviation: Shows the ratio between frame store data and true dimensions of an image.

Sub-sampling

Sub-sampling is the process of skipping neighboring pixels (with the same color) while being read out from the CMOS or CCD chip.

CMOS equipped MARLIN models, both color and b/w have this feature (FW > 2.03).

E.g. the CCD model MARLIN F-146C is also equipped with this mode, acting as a preview mode. Because it is realized digitally there is no further speed increase.

Sub-sampling is used primarily for 2 reasons:

- A reduction in the number of pixels and thus the amount of data while retaining the original image area angle and image brightness
- CMOS: an increase in the frame rate.

Similar to binning mode the cameras support horizontal, vertical and h+v sub-sampling mode.

Trigger

Trigger is an input to an industrial digital camera that initiates the image capture sequence. Otherwise, an electrical signal or set of signals used to synchronize a camera, or cameras, to an external event.

The term **trigger** is sometimes used in the sense of a trigger shutter.

Trigger shutter

A trigger shutter is a shutter mode with random timing or even with random shutter speed. Such randomness is controlled by the trigger signal mentioned above.

USB

Universal **S**erial **B**us (USB) provides a serial bus standard for connecting devices, usually to computers such as PCs, but is also becoming commonplace on digital cameras.

Vertical binning

Vertical binning increases the light sensitivity of the camera by a factor of two by adding together the values of two adjoining vertical pixels output as a single pixel. At the same time this normally improves signal-to-noise separation by about 2 dB.

See also: full binning and horizontal binning

WDM

WDM = **W**indows **D**river **M**odel

In computing, the Windows Driver Model (WDM) - also known (somewhat misleadingly) at one point as the Win32 Driver Model - is a framework for device drivers that was introduced with Windows 98 and Windows 2000 to replace VxD, which was used on older versions of Windows such as Windows 95 and Windows 3.1 and the Windows NT Driver Model.

White balance

A function enabling adjustment of the image colors to make the white objects really appear as white. Thus one can avoid color shifts caused e.g. by differing illumination conditions.

YUV

The YUV model defines a color space in terms of one luma and two chrominance components. YUV is used in the PAL and NTSC systems of television broadcasting, which are the standards in much of the world.

YUV models human perception of color more closely than the standard RGB model used in computer graphics hardware, but not as closely as the HSL color space and HSV color space.

Y stands for the luma component (the brightness) and U and V are the chrominance (color) components.

YUV signals are created from an original RGB (red, green and blue) source. The weighted values of R, G and B are added together to produce a single Y signal, representing the overall brightness, or luma, of that spot. The U signal is then created by subtracting the Y from the blue signal of the original RGB, and then scaling; and V by subtracting the Y from the red, and then scaling by a different factor.

An advantage of YUV is that some of the information can be discarded in order to reduce bandwidth. The human eye has fairly little color sensitivity: the accuracy of the brightness information of the luma channel has far more impact on the image discerned than that of the other two.

(See also 4:2:2 and 4:1:1)