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chrominance (1) the color information in the video signal that is defined in terms of hue and saturation.

(2) the component of color which is independent of, and complementary to *luminance*; *chrominance* is 2-D: for example, it can be decomposed into *hue* and *saturation*. *See* hue, intensity, luminance, saturation.

chronaxie the minimum duration of a unidirectional square-wave current needed to excite a nerve when the current magnitude is twice rheobase.

CIE *See* Commision International d'Eclairage.

CIE diagram the projection of the plane $(X + Y + Z) = 1$ onto the XY plane, where X, Y, Z are the respective tristimulus values as defined by the CIE (*See* tristimulus value and Commision International d'Eclairage). The CIE diagram shows all of the visible chromaticity values and maps all colors with the same chromaticity but different value (luminances) onto the same points.

CIM *See* computer-integrated manufacturing.

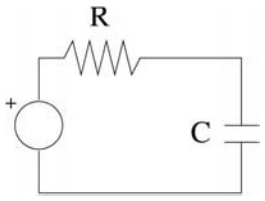
CIR *See* carrier-to-interference ratio.

circle detection the location of circles in an image by a computer. Often accomplished with the Hough transform.

circle diagram (1) graphical representation of the operation of an induction machine. It is based on the approximate equivalent circuit and expresses stator and rotor current relations for all operating modes (motor, braking, generator) and all values of slip. Several variations of the diagram exist.

(2) graphical representation of the power flow through a transmission line. The maximum power flow through the line can be determined by the impedance of the line.

circuit a physical device consisting of an interconnection of elements, or a topological model of such a device. For example, an electric circuit may be constructed by interconnecting a resistor and a capacitor to a voltage source. A representation of this circuit is shown by the diagram in the figure.



Circuit example.

circuit (STM) switching technology that provides a direct connection between two endpoints; data is transferred directly between the endpoints of a circuit without being stored in any intermediate nodes.

circuit breaker a circuit breaker is a device that makes and breaks the electrical contact between its input and output terminals. The circuit breaker is capable of clearing fault currents (tripping) as well as load currents. The circuit breaker consists of power contacts with arc clearing capability and associated control and auxiliary circuits for closing and tripping the breaker under the required conditions.

circuit protection devices or control measures used to safeguard electrical circuits from unsafe operating regions, such as overcurrents and overvoltages.

circuit switching a method of communication in which a physical circuit is established between two terminating equipments before communication begins to take place. This is analogous to an ordinary phone call.

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compensator a system block added to an existing system (or process) to produce a combined transfer function that improves its performance when connected in a closed loop configuration. *See also* compensation, pre-compensator and post-compensator.

compensatory behavior human dynamic behavior in which the operator's actions are conditioned primarily by the closed-loop man-machine system errors.

compensatory display for the simplest case, a display which shows only the difference between the desired input command and the system output.

compiler a program that translates a high level language program into an executable machine instruction program or other lower-level form such as assembly language. *See also* linker, assembler, interpreter, cross-assembler, cross-compiler.

complement (1) to swap 1's for 0's and 0's for 1's in a binary number.

(2) opposite form of a number system.

complement of a fuzzy set the members outside of a fuzzy set but within the universe of discourse. Represented by the symbol $\neg$.

Let A be a fuzzy set in the universe of discourse X with membership function $\mu_A(x)$, $x \in X$. The membership function of the complement of A , for all $x \in X$, is

$$\mu_{\neg A}(x) = 1 - \mu_A(x)$$

See also complement, fuzzy set, membership function.

complement operator the logical NOT operation. In a crisp (non-fuzzy) system, the complement of a set A is the set of the elements that are not members of A. The fuzzy complement represents the degree to which an element is not a member of the fuzzy set.

complementary arithmetic a method of performing integer arithmetic within a computer, in which negative numbers are represented in such a way that the arithmetic may be performed without regard to the sign of each number.

complementary cumulative distribution function (CCDF) a function describing the probability $p(x)$ of achieving all outcomes in an experiment greater than x.

complementary metal oxide semiconductor (CMOS) (1) refers to the process that combines n-channel and p-channel transistors on the same piece of silicon (complementary). The transistors are traditionally made of layers of metal, oxide, and semiconductor materials, though the metal layer is often replaced by polysilicon. There are a number of variations such as HCMOS, high-speed CMOS which scales down the elements compared to the standard MOS process and thus increases the speed and reduces the power consumption for each transistor in the CPU.

(2) a CMOS memory device used in computers to store information that must be available at startup. The information is maintained in the device by a small battery.

complete statistic a sufficient statistic T where every real-valued function of T is zero with probability one whenever the mathematical expectation of that function of T is zero for all values of the parameter. In other words, if W is real-valued function, then T is complete if

$$E_\theta W(T) = 0 \forall \theta \in \Theta \Rightarrow P_\theta[W(T) = 0] = 1 \forall \theta \in \Theta$$

completion unit *See* retire unit.

complex amplitude magnitude of a nearly harmonic function, complex to include phase deviations from a reference wave.

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donor an impurity in a semiconductor that donates a free electron to the conduction band.

door *See* lid.

dopant an impurity substance (such as phosphorus or boron) added in very small controlled quantities to a semiconductor base material (such as silicon or gallium arsenide), thereby changing the material conduction characteristics by modifying electron and/or hole concentration. A donor dopant is one that gives rise to electrons and an acceptor dopant is one that gives rise to holes.

doping the process of introducing impurity atoms into pure silicon to change its electrical properties. The impurities may be either n-type (introducing an additional conducting electron) or p-type (introducing the absence of a conducting electron, also called a "hole").

Doppler broadened lineshape function spectral function that results from Doppler shifts caused by the velocity distribution of atoms or molecules in a gas; a Gaussian function for a Maxwellian velocity distribution.

Doppler broadening broadening of a spectral line due to Doppler shifts caused by the random motion of atoms or molecules in a vapor.

Doppler effect *See* Doppler shift.

Doppler filter a filter used to resolve targets from each other and from extraneous returns from other objects (called clutter) by filtering in the velocity or Doppler domain. So-called because the Doppler effect causes frequency shifts proportional to velocity variations in tracked objects.

Doppler frequency a shift in frequency of the returned power from a target as a result of the target's motion relative to the illuminating source.

Doppler linewidth characteristic width of a Doppler-broadened spectral line; usually the full width at half maximum when the line is Gaussian.

Doppler power spectrum a function characterizing the spread of average received power as a function of Doppler shift. Can be obtained from the scattering function by integrating over the delay variable. *See also* scattering function, multipath propagation.

Doppler radar radar-based technique used in measuring the velocity of a moving target or wind by measuring the Doppler shift (Doppler effect).

Doppler shift a frequency shift in a received signal caused by time-variant transmission delay, or equivalently time-variant propagation path length. This in turn is caused by movement of terminals with respect to each other, or by movement of reflecting objects. In optics, frequency shifts imposed on laser beams such as when used in laser radar or when diffracted by an acoustic wave.

The Doppler shift depends on the frequency of the signal and the angle of arrival of the signal relative to the direction of movement of the receiver. For a signal consisting of a range of frequencies, each frequency component will experience a different shift. Hence the received signal will have a different bandwidth than the transmitted signal (Doppler dispersion).

For a tone (continuous-wave) signal of frequency f, the Doppler shift f_D observed on a single propagation path of changing length is given by

$$f_D = \frac{f v}{c} ,$$

where v is the rate (in m/s) of path length change, and c is the speed of light.

Also known as Doppler effect.

Doppler spread the increase of bandwidth of a signal due to doppler shifting of

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field-effect transistor (FET) a majority-carrier device that behaves like a bipolar transistor with the important difference that the gate has a very high input impedance and therefore draws no current.

An active device with three terminals — gate, source, and drain — in the active (amplifier) mode of operation, the drain current is related to the gate-source voltage. The relationship is usually approximated by a square law, but there are significant deviations from the square law depending on factors such as device geometry. The FET can also be used as a switch, with the gate-source voltage controlling the "on/off" state of the conducting channel between source and drain terminals. The input resistance at the gate is extremely high (usually of order tens of megaohms) and the gate current is negligibly small (usually of order picoamperes or less).

There are various families of FETs, including MOSFETs and JFETs. Within each family, there are two types of FET, n-channel and p-channel (named for the sign of the majority carriers that form the current conducting path between source and drain).

Some FETs also have a fourth terminal, the "substrate" or "body" terminal. The p-n junctions between the substrate and the drain and source terminals should be reverse-biased to insure proper device operation.

field-oriented control speed control of an induction motor obtained by varying the magnitude and orientation of the airgap magnetic field. This is also referred to as vector control and requires sensing of the rotor position. Vector controllers allow the induction motor to operate very much like a DC motor, including development of rated torque at zero speed.

field-programmable gate array (FPGA) (1) a programmable logic device that consists of a matrix of programmable cells embedded in a programmable routing mesh. The combined programming of the cell functions and routing network define the function of the device.

(2) a gate array with a programmable multi-level logic network. Reprogrammability of FPGAs make them generic hardware and allow them to be reprogrammed to serve many different applications. FPGAs consist of SRAMS, gates, latches, and programmable interconnects.

FIFO *See* first-in-first-out.

FIFO memory commonly known as a queue. It is a structure where objects are taken out of the structure in the order they were put in. Compare this with a LIFO memory or stack. A FIFO is useful for buffering data in an asynchronous transmission where the sender and receiver are not synchronized: the sender places data objects in the FIFO memory, while the receiver collects the objects from it.

figure of merit performance evaluation measure for the various target and equipment parameters of a sonar system. It is a subset of the broader sonar performance given by the sonar equations, which includes reverberation effects.

file format the structure of the computer file in which an image is stored. Often the format consists of a fixed-size header followed by the pixel values written from the top to the bottom row and within a row from the left to the right column. However, it is also common to compress the image. *See also* Graphics Interchange Format, header, image compression, tagged image file format (TIFF).

Filippov method a definition of a solution to a system of first-order differential equations with discontinuous right-hand side,

$$\dot{\mathbf{x}} = \mathbf{f}(t, \mathbf{x}) \ ,$$

proposed by A. F. Filippov. A vector function $\mathbf{x}(t)$ defined on the interval $[t_1, t_2]$ is a solution to the above system of differential equations in the sense of Filippov, if it is absolutely continuous and for almost all

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specifically for the execution of integer-type instructions.

integral control control scheme whereby the signal that drives the actuator equals the time integral of the difference between the input/desired output and the measured actual output.

integral equation a type of equation where the unknown function appears under an integral. When this is the only place that the unknown appears, the integral equation is commonly called a first-kind equation, while if the unknown also appears outside the integral, it is a second-kind integral equation.

One-dimensional examples are

$$y(s) = \lambda \int_a^b K(s,t)x(t)dt$$

and

$$x(s) = y(s) + \lambda \int_a^b K(s,t)x(t)dt$$

where λ is a possibly complex scalar parameter and $y(s)$ is known (often called the driving term); $x(t)$ is the unknown function and $K(s,t)$ is the known kernel. The above are linear Fredholm integral equations of the first and second kind, respectively.

integral horsepower motor a motor built in a frame as large as or larger than that of a motor of open construction having a continuous rating of one horsepower at 1700–1800 rpm.

integrated AOTF acousto-optical tunable filter device using integrated wave guide optics and surface acoustic waves (SAWs) for acousto-optical interaction.

integrated circuit (IC) (1) an assembly of miniature electronic components simultaneously produced in batch processing, on or within a single substrate, that performs an electronic circuit function.

(2) many transistors, resistors, capacitors, etc., fabricated and connected together to make a circuit on one monolithic slab of semiconductor material.

integrated optics also known as guided-wave optics; generally, describes the devices that couple to fiber optics, but does not include the fibers.

integrated project support environment a software engineering environment supporting all the stages of the software process from initial feasibility studies to operation and maintenance.

integrated services digital network (ISDN) a network that provides end-to-end digital connectivity to support a wide range of services, including voice and nonvoice services, to which users have access by a limited set of standard multipurpose user–network interfaces.

integrating A/D device that takes an analog input signal and integrates it over time to produce a digital signal that represents the area under the curve, or the integral.

integrator for an input of $x(t)$ and an output of $\int_{-\infty}^{t} x(\tau)d\tau$, is one of the basic signal processing building blocks. Integrators can be implemented using operational amplifiers.

integrity (of data) (1) a belief in the truth of the information represented by a set of data.

(2) a condition stating that the information in a set of data does satisfy a set of logical constraints (the integrity constraints).

intelligence the aggregated and processed information about the environment, including potential adversaries, available to commanders and their staff.

intelligent control a sensory-interactive control structure incorporating cognitive characteristics that can include artificial intelligence techniques and contain knowledge-based constructs to emulate learning behav-

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(VCO) free-running frequency over which the VCO will, once locked, remain synchronized with the signal frequency. Lock range is sometimes called tracking bandwidth.

lock-in amplifier a system for detecting weak, noisy periodic signals based on Synchronous detection, and incorporating all the other components necessary for recording the amplitude profile of the weak incoming signal, including input AC amplifier, diode or other detectors, low-pass filter, DC amplifier, and any special filters. Such instruments are nowadays constructed with increasing amounts of digital and computerized circuitry, depending on the frequency of operation.

lock-out phenomenon exhibited during channel switching that results from a fast automatic gain control (AGC) system interacting with the horizontal automatic frequency control (AFC), thereby reducing the pull-in range of the AFC system.

lock-up-free cache *See* nonblocking cache.

locked-rotor current the current drawn by an induction motor when the shaft is not moving and rated voltage is applied. The starting current is essentially equal to the locked rotor current and may be as much as eight times the rated current of the machine.

locked-rotor torque the torque produced in an induction motor when the rotor is locked and rated AC voltage is applied to the stator.

locking *See* bus locking.

lockout the condition following fault clearing when the circuit will not attempt a reclose. Transformers, generators, and buses typically trip once and lockout immediately. Transmission lines and distribution lines will generally attempt one or more recloses, and will lockout if the fault remains following the last reclose in the sequence.

lockout relay an auxiliary relay which is operated by protective relay(s) that in turn opens the appropriate circuit breakers or other fault clearing devices. The lockout relay will remain in the trip position until manually reset, and is used in protective zones where temporary faults are unusual and the potential for equipment damage is high.

LOCOS *See* local oxidation of silicon.

log periodic antenna broadband antenna designed using physical dimensions (lengths, spacings, diameters, etc.) that vary logarithmically. The result of such designs is an antenna whose performance parameters (e.g., input impedance) is periodic with respect to the logarithm of the frequency.

log-likelihood function the likelihood function of y given x is the conditional PDF, $p(y|x)$. The log-likelihood function is the logarithm of the likelihood function, $\log(p(y|x))$.

log-normal distribution probability distribution with density

$$f(x) = 1/(\sqrt{(2\pi)}\sigma x)e^{-((\log x-\mu)^2/(2\sigma^2))}$$

where μ and σ are the mean and standard deviation of the logarithm.

logarithmic quantization a method for non-linear scalar quantization where the input signal is transformed logarithmically and then coded using uniform quantization. The transformation is utilized to enhance performance for sources having nonuniform probability distribution, and to give robustness towards varying input signal dynamics.

logic analyser a machine that can be used to send signals to, and read output signals from, individual chips or circuit boards.

logic circuit a circuit that implements a logical function, such as AND, OR, NAND, NOR, NOT, or XOR. (DB)

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router a node, connected to multiple networks, that forwards packets from one network to another. It is much more complex than bridges that work between networks having compatible protocols. Also called a gateway.

routing given a collection of cells placed on a chip, the routing routine connects the terminals of these cells for a specific design requirement.

row decoder logic used in a direct-access memory (ROM or RAM) to select one of a number of rows from a given row address. *See also* two-dimensional memory organization.

row-access strobe *See* two-dimensional memory organization.

RS flip-flop a single-bit storage element, usually formed by connecting two NOR or NAND gates in series. RS stands for reset–set. For state variable Q and next state variable Q', the simplified truth table is given as

R	S	Q	Q'
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	X
1	1	1	X

the symbol "X" is used to denote an unknown state for the flip-flop. *See also* JK flip-flop.

RS-170A technical standard developed by the Electronics Industry Association that describes in detail the relationship between vertical, horizontal, and subcarrier components within a video signal. The standard permits synchronization of two or more video signals.

RS-422 technical standard developed by the Electronics Industry Association that defines the exact physical, electrical, and functional characteristics for a 40-pin connector that links a computer to communication equipment.

RSGNN *See* recursive self-generating neural network.

RSSI *See* received signal strength indicator.

RTB reverse translation buffer. *See* inverse translation buffer.

RTU *See* remote terminal unit.

rubbers personal protective wear for line workers, including insulating gloves, sleeves, and rubber boots.

ruby amplifying medium employed in the first man-made optical frequency laser.

ruby laser first man-made optical frequency laser.

run winding the main winding of a single-phase induction motor.

run-length coding the assignment of a codeword to each possible run of 0s (white pel sequence) or run of 1s (black pel sequence) in a scan of the subject copy.

run-length encoding *See* run-length limited code.

run-length limited (RLL) code a line code that restricts the minimum and/or maximum number of consecutive like-valued symbols that can appear in the encoded symbol sequence.

running digital sum the difference between cumulative totals of the number of logic 1s and number of logic 0s in a binary sequence. It is a common measure in the performance of a line code.

running integral for the function $x(t)$, the running integral, $y(t)$ is $y(t) = \int_{-\infty}^{t} x(\tau)d\tau$.

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signal level the value of a signal at a particular place and time.

signal processing a generic term that refers to any technique that manipulates the signal, including but not limited to signal averaging, signal conditioning and signal recognition. When applied to images, it is normally referred to as image processing, the term signal processing usually being reserved for 1-D signals.

signal recognition the recognition of signals by appropriate analysis, often with the help of filters such as matched filters or frequency domain filters.

signal recovery the process of extraction of signals from a background of noise or clutter, often in situations, where the signal-to-noise ratio is so low that matched filters, synchronous detectors or lock-in amplifiers have to be used. *See also* synchronous detection.

signal reference subsystem this subsystem provides the reference points for all signal grounding to control static charges, noise, and interference. It may consist of any one or a combination of the lower frequency network, higher frequency network, or hybrid signal reference network.

signal restoration the restoring of data that has been corrupted by instrumentation dynamics and noise.

signal subspace in an orthogonal decomposition of a space, the part to which the desired signal belongs. *See also* noise subspace.

signal transfer point (STP) a packet switch found in the common-channel signaling network; it is used to route signaling messages between network access nodes such as switches and SCPs.

signal variance *See* variance.

signal-to-interference ratio (SIR) the ratio of the average power of the signal component to the average power of the interference component in a case where an information-bearing signal of interest has been corrupted by interfering signals.

signal-to-noise plus interference ratio (SNIR) the ratio of total signal power to the sum of total noise power and total interference power at a receiver. The SNIR is a more complete indicator of received signal quality than either SIR or SNR, where the relative contribution of receiver noise and external sources of interference are either unknown or widely varying. It is a unitless quantity. *See also* signal-to-noise ratio, signal-to-interference ratio.

signal-to-noise ratio (SNR) the ratio of the average power of the information signal component to the average power of the noise component in a signal consisting of the sum of an information signal component and a corrupting noise component. It is a unitless quantity.

signaling procedures used to control (set up and clear down) calls and connections within a telecommunication network.

signaling system 7 (SS7) a communications protocol used in common-channel signaling networks.

signature a characteristic easily computed feature or function by which a particular object or signal may be at least tentatively identified. An example is the centroidal profile for an object having a well defined boundary.

signature analysis (1) a test where the responses of a device over time are compared to a characteristic value called a signature, which is then compared to a known good one.

(2) an analysis of the signature to extract the desired (signal) information.

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transition matrix of 2-D Roesser model denoted T_{ij},

$$\begin{bmatrix} x^h_{i+1,j} \\ x^v_{i,j+1} \end{bmatrix} = \begin{bmatrix} A_1 & A_2 \\ A_3 & A_4 \end{bmatrix} \begin{bmatrix} x^h_{ij} \\ x^v_{ij} \end{bmatrix} + \begin{bmatrix} B_1 \\ B_2 \end{bmatrix} u_{ij}$$

$i, j \in Z_+$ (the set of nonnegative integers) is defined as follows:

$$T_{ij} = \begin{cases} I_n \text{ for } i = j = 0 \\ \begin{bmatrix} A_1 & A_2 \\ 0 & 0 \end{bmatrix} \text{ for } i = 1, \ j = 0 \\ \begin{bmatrix} 0 & 0 \\ A_3 & A_4 \end{bmatrix} \text{ for } i = 0, \ j = 1 \text{ and} \\ T_{10}T_{i-1,j} + T_{01}T_{i,j-1} \\ \text{for } i, j \in Z_+ \ \ (i + j \neq 0) \\ 0 \ \text{ for } i < 0 \text{ or/and } j < 0 \end{cases}$$

where $x^h_{ij} \in R^{n_1}$ and $x^v_{ij} \in R^{n_2}$ are the horizontal and vertical state vectors, $u_{ij} \in R^m$ is the input vector, A_1, A_2, A_3, A_4, B_1, B_2 are real matrices.

transition rate rate at which atoms undergo transitions from one level to another due to stimulated and spontaneous processes as well as inelastic collisions; reciprocal of transition lifetime.

transition region the region of the I-V curve(s) of a device between the ohmic region and the current source region, in which the slope of the I-V curve(s) is rapidly changing as it transitions from the resistance region to the current source region.

translation a geometric transformation which simply adds an offset to the pixel coordinates of an image.

translation lookaside buffer (TLB) essentially a small fully associative address-cache used to provide fast address translation for the most used virtual addresses. The TLB is associatively searched on a virtual address, and in the event of a hit, it returns the corresponding real address. In the event of a miss, if the addressed page is in main memory, then a TLB entry is made for it; otherwise the page is first brought in after a page fault and then the TLB entry is made. In either case, the TLB eventually returns a real address. The TLB may be fully associative, set associative, or hashed.

translator an unattended television or FM broadcast repeater that receives a distant signal and retransmits the picture and/or audio locally on another channel.

transmission (1) the act of sending information from one location to another.

(2) transformation of an optical wave incident on a surface that passes a portion of the wave to the medium behind the surface.

(3) that class of electric power system work which is concerned with the transport of electric power from the generator to the area of consumption. The circuits of interest typically extend at the generating station and terminate at the local substation.

transmission coefficient a number that describes the relative amplitude and phase of the transmitted wave with respect to the incident wave. The term is usually used in the context of wave transmission at a material interface or transmission line.

transmission grating a diffraction grating that operates in transmission, i.e., the diffracted light is obtained by shining light through the grating.

transmission line (1) an arrangement of two or more conductors used to convey electromagnetic energy from one point to another.

(2) conductive connections that guide signal power between circuit elements.

transmission line coupler passive coupler composed of two or more transmissions spaced closely together where the proximity of the transmission lines allows signals to be coupled or transferred in part from one line to the other. The electrical length of the transmission lines is usually one quarter of a wavelength.

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