DIGITAL TV: DIGITIZED VIDEO

Video professionals at television studios have been using various digital formats, such as D1 (components) and D2 (composite), for recording and editing video signals. In order to ease the interoperability of equipment and international program exchange, the **CCIR** has standardized conditions of digitization and interfacing of digital video signals in component format. The main advantages of these digital formats are that they allow multiple copies to be made without any degradation in quality, and the creation of special effects not otherwise possible in analog format, and they simplify editing of all kinds, as well as permittinginternational exchange independent of the broadcast standard to beused for diffusion. The drawback is the very important bit-rate, which makes theseformats unsuitable for transmission to the end user without priorsignal compression.

Digitization formats

If one wants to digitize an analog signal of bandwidth Fmax, it isnecessary to sample its value with a sampling frequency Fs of atleast twice the maximum frequency of this signal to keep its integrity(Shannon sampling theorem). This is to avoid the negative **aliasing**effects of spectrum fall-back: in effect, sampling a signal creates twoparasitic sidebands above and below the sampling frequency, whichrange from Fs−Fmax to Fs+Fmax, as well as around harmonics of thesampling frequency (Fig. 2.1).In order to avoid mixing the input signal spectrum and the lowerpart of the first parasitic sideband, the necessary and sufficientcondition is that Fs−Fmax >Fmax, which is realized if Fs>2Fmax. Thismeans that the signal to be digitized needs to be efficiently filteredin order to ensure that its bandwidth does not exceed Fmax= Fs/2.

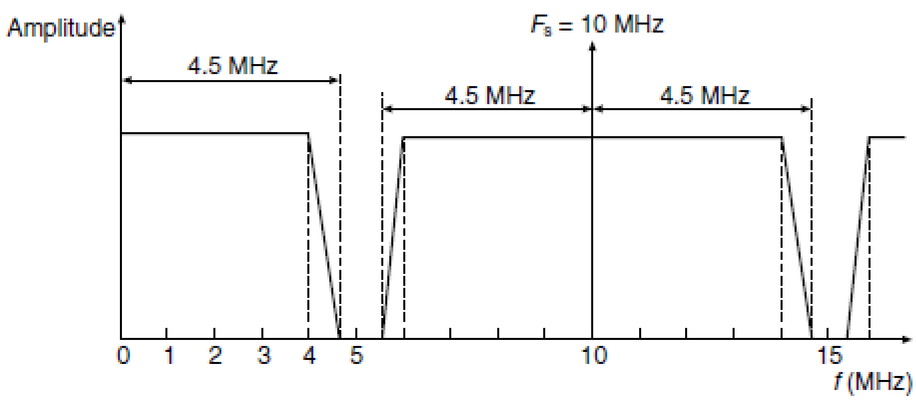


Figure 2.1 Spectrum of a sampled signal (when $F_s > 2 \times F_{max}$).

For ***component video*** signals from a studio source, which can have a bandwidth of up to 6 MHz, the CCIR prescribes a sampling frequency of Fs =13.5MHz locked on the line frequency. The number of active samples per line is 720 in both cases. In such a line-locked sampling system, samples are at the same fixed place on all lines in a frame, and also from frame to frame, and so are situated on a rectangular grid. For this reason, this sampling method is called orthogonal sampling (Fig. 2.2).

In ***composite video sampling***, the sampling frequency will be **4*F_{sc}**(sub-carrier frequency). The sub-carrier frequency for 625 line system is 4.43 MHz and for 525 line system is 3.58 MHz. Hence, the sampling frequency for 625 line system is 4*4.43 MHz and for 525 line system is 4*3.58 MHz.

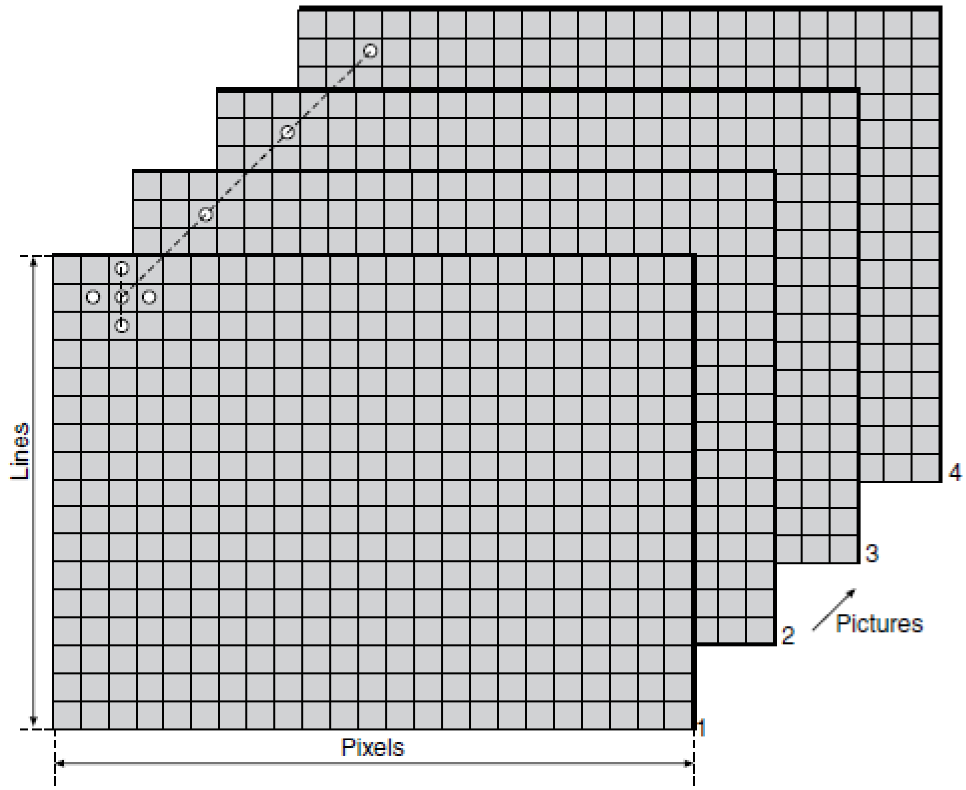


Figure 2.2 Orthogonal sampling structure of a picture.

VIDEO FORMATS

The 4:2:2 format

Recommendation CCIR-601, established in 1982, defines digitization parameters for video signals in component form based on a Y, Cb, Cr signal in 4:2:2 format (four Y samples for two Cb samples and two Cr samples) with 8 bits per sample (with a provision for extension to 10 bits per sample). The sampling frequency is 13.5MHz for luminance and 6.75MHz for chrominance, regardless of the standard of the input signal. This results in 720 active video samples per line for luminance, and 360 active samples per line for each chrominance. The position of the chrominance samples corresponds to the odd samples of the luminance (see Fig.

2.3). Chrominance signals Cr and Cb being simultaneously available at every line, vertical resolution for chrominance is the same as for luminance. The total bit-rate resulting from this process is13.5×8+2×6.75×8 = 216 Mb/s. With a quantization of 10 bits, the bit-rate becomes 270 Mb/s. However, if one takes into account the redundancy involved in digitizing the inactive part of the video signal (horizontal and vertical blanking periods), the useful bit-rate goes down to 166 Mb/s with 8 bits per sample. These horizontal and vertical blanking periods can be filled with other useful data, suchas digital sound, sync, and other information.

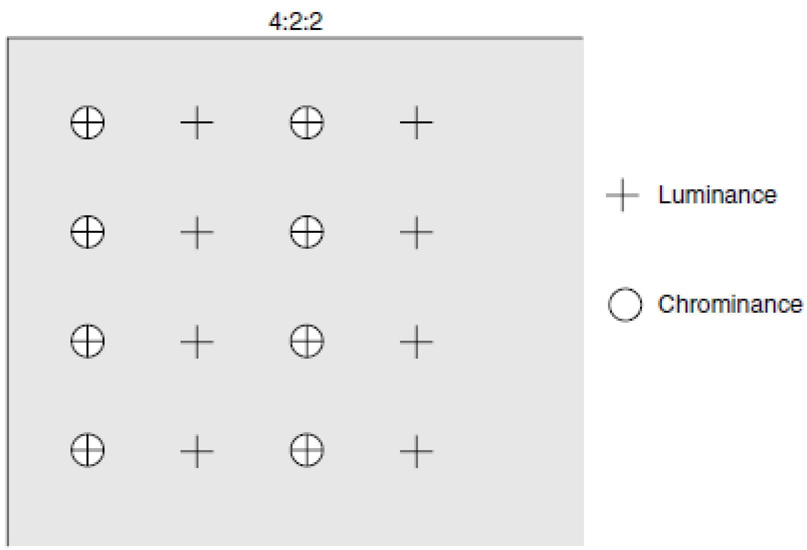


Figure 2.3 Position of samples in the 4:2:2 format.

4:2:0, SIF, CIF, and QCIF formats

For applications that are less demanding in terms of resolution, andin view of the bit-rate reduction, a certain number of *byproducts* ofthe 4:2:2 format have been defined, as follows.

The 4:2:0 format

This format is obtained from the 4:2:2 format by using the samechroma samples for two successive lines, in order to reduce the amount of memory required in processing circuitry while at the sametime giving a vertical resolution of the same order as the horizontalresolution. Luminance and horizontal chrominance resolutions arethe same as for the 4:2:2 format, and thus

• luminance resolution: 720×576 (625 lines) or 720×480 (525lines);

• chrominance resolution: 360×288 (625 lines) or 360×240 (525lines).

Figure 2.4 shows the position of chroma samples in the 4:2:0 format.Cb and Cr samples are obtained by interpolating 4:2:2 samplesof the two successive lines and they will “color-ize” at display time.This 4:2:0 format is of special importance as it is the input formatused for D2-MAC and MPEG-2 (MP@ML) coding.

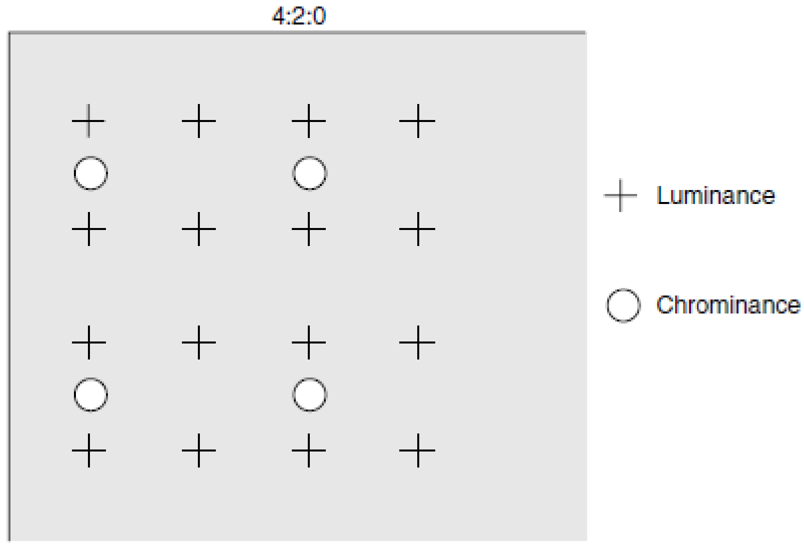


Figure 2.4 Position of samples in the 4:2:0 format.

The SIF (source intermediate format)

This format is obtained by halving the spatial resolution in bothdirections as well as the temporal resolution, which becomes 25 Hzfor 625-line systems and 29.97 Hz for 525-line systems. Dependingon the originating standard, the spatial resolutions are then:

• luminance resolution: 360×288 (625 lines) or 360×240 (525lines);

• chrominance resolution: 180×144 (625 lines) or 180×120 (525lines).

Figure 2.5 illustrates the position of the samples in the SIF format.Horizontal resolution is obtained by filtering and sub-sampling theinput signal. The reduction in temporal and vertical resolution isnormally obtained by interpolating samples of the odd and evenfields, but is sometimes achieved by simply dropping every secondfield of the interlaced input format. The resolution obtained is thebase for MPEG-1 encoding, and is resulting in a so-called “VHS-like” quality in terms of resolution.

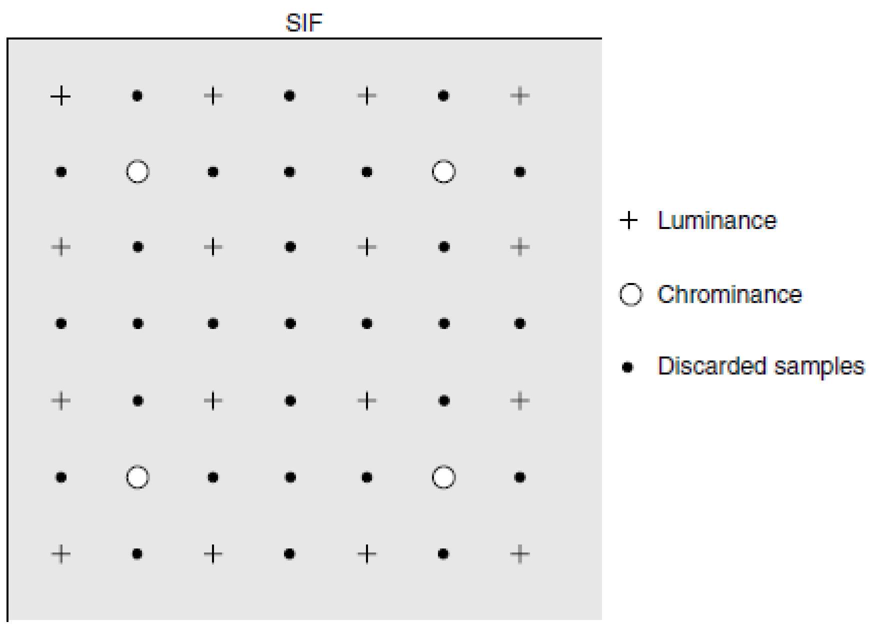


Figure 2.5 Position of samples in the SIF format.

The CIF (common intermediate format)

This is a compromise between European and American SIF formats:spatial resolution is taken from the 625-line SIF (360×288) andtemporal resolution from the 525-line SIF (29.97 Hz). It is the basisused for video conferencing.

The QCIF (quarter CIF)

Once again, this reduces the spatial resolution by 4 (2 in each direction)and the temporal resolution by 2 or 4 (15 or 7.5 Hz). It is theinput format used for ISDN videotelephony using the H261 compressionalgorithm.

High definition formats 720p, 1080i

Two standard picture formats have been retained for broadcastHDTV applications, each existing in two variants:

- The 720p format: this is a progressive scan format with a horizontalresolution of 1280 pixels and a vertical resolution of 720lines (or pixels).

- The 1080i format: this interlaced format offers a horizontal resolutionof 1920 pixels and a vertical resolution of 1080 lines (orpixels).

For these two formats, the horizontal to vertical resolution areequivalent (*square pixels*) because they have the same ratio as theaspect ratio of the picture (16:9).

These two HD formats gives bit-rates on the order of 1 to 1.5 Gb/s depending on the frame rate and resolution, which is4 to 5 times greater than for standard-definition interlaced video.

SOURCE CODING OF DIGITIZED VIDEO

Compression is an absolute must in order to be able to broadcast TV pictures in a channel of acceptable width. The compression methods use general data compression algorithms applicable to any kind of data, and exploit thecorrelation of neighboring points within an image and the lack of sensitivity of the eye to fine details for fixed pictures (JPEG), and the very high temporal redundancy betweensuccessive images in the case of moving pictures (MPEG).

Some general data compression principles

1. Run length coding (RLC)

When an information source emits successive message elementswhich can deliver relatively long series of identical elements, it is advantageous to transmit thecode of this element and the number of successive occurrencesrather than to repeat the code of the element; this gives a variablecompression factor (the longer the series, the bigger the compressionfactor). This type of coding which does not lose any informationis defined as reversible. This method is commonly employed for filecompression related to disk storage or transmission by computers(zip, etc.); it is also the method used in fax machines.

2. Variable length coding (VLC) or entropy coding

In orderto reduce the bit-rate required to transmit the sequences generatedby the source, it is advantageous to encode the most frequent elementswith less than n bits and the less frequent elements withmore bits, resulting in an average length that is less than a fixedlength of n bits.This bit-rate reduction method is based on the fact that the probabilityof occurrence of an element generated by a source and codedon 'n' bits is sometimes not the same for all elementsamong the 2^n different possibilities.

However, if this is to be done in real time, it implies a previousknowledge of the probability of occurrence of each possible elementgenerated by the source. Thisallows this method to be used for text compression. This methodis also valid for video images compressed by means of DCT, whereenergy is concentrated on a relatively small number of coefficients,as opposed to the temporal representation of the video signal whereall values are almost equiprobable.

The information quantity Q transmitted by an element is equal to the logarithm (base 2) of the inverse of its probability of appearance p:

$$Q = \log_2(1/p) = -\log_2(p)$$

The sum of the information quantity of all elements generated by a source multiplied by their probability of appearance is called the entropy, H, of the source:

$$H = \sum_i pi \log_2(1/pi)$$

The most well-known method for variable length coding is the Huffmann algorithm.

Compression of fixed pictures

The first applications aimed at reducing the amount of informationrequired for coding fixed pictures appeared in the 1980s, andthey had as their primary objective the significant reduction of thesize of graphics files and photographs in view of storing or transmittingthem. In 1990, the **ISO** (International Standards Organization)created an international working group called **JPEG** (JointPhotographic Experts Group) which had the task of elaborating aninternational compression standard for fixed pictures of various resolutionsin Y, Cr, Cb, or RGB format. The resulting internationalstandard (widely known as JPEG) was published in 1993 under thereference ISO/IEC 10918, and it can be considered as a toolbox forfixed picture compression.

It should be noted that JPEG compression can be either **lossy**or **lossless** (reversible), depending on the application and thedesired compression factor. Most common applications use the lossy method, which allows compression factors of more than 10 to beachieved without noticeable picture quality degradation, dependingon the picture content.

Lossy JPEG compression can be described in six main steps:

1. *Decomposition of the picture into blocks.* The picture, generallyin Y, Cb, Cr format, is divided into elementary blocks of 8×8pixels (Fig. 3.2), which represents for a 4:2:2 CCIR-601 picturea total number of 6480 luminance (Y) blocks and 3240blocks for each Cr and Cb component. Each block is made upof 64 pixel values (numbers) ranging from 0 to 255 (when digitized on 8 bits)for luminance, and −128 to +127 for chrominance Cr and Cb.

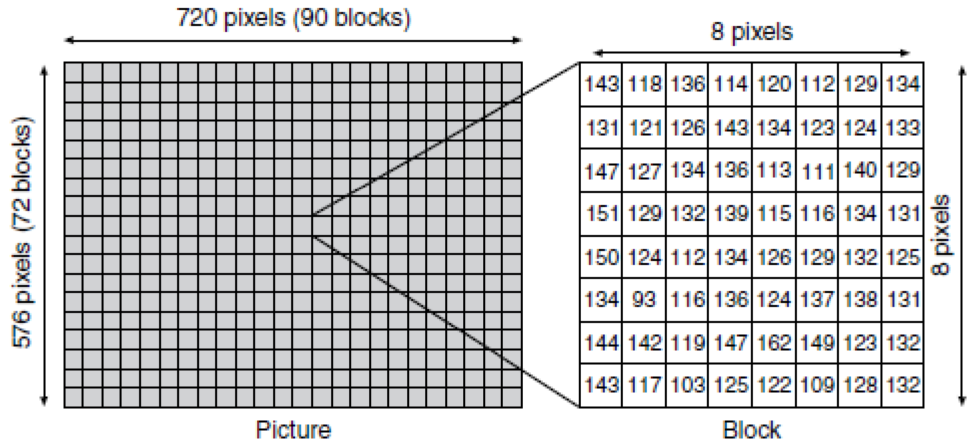


Figure 3.2 Cutting out blocks of 8 × 8 pixels (values represent the luminance of a pixel).

2. *Discrete cosine transform.* As explained previously, the DCTapplied to each Y, Cb, Cr block generates for each one a new8 × 8 matrix made up of the coefficients of increasing spatialfrequency as one moves away from the origin (upper left corner)which contains the DC component representing the averageluminance or chrominance of the block. The value of these coefficients decreases quickly when going away from the originof the matrix, and the final values are generally a series of smallnumbers or even zeros. So, if the block is of uniform luminanceor chrominance, only the DC coefficient will not be zero, andonly this coefficient will have to be transmitted.

3. *Thresholding and quantization.* This step takes into accountthe specificities of human vision, particularly the fact that theeye does not distinguish fine details below a certain luminancelevel. It consists of zeroing the coefficients below a predeterminedthreshold, and quantizing the remaining ones withdecreasing accuracy as the frequency increases. Contrary tothe 63 other (AC) coefficients, the DC coefficient is **DPCM** coded(differential pulse code modulation) relative to the DC coefficientof the previous block, which allows a more accurate codingwith a given number of bits. This allows the visibility of theblocks on the reconstructed picture to be reduced, as the eye,although not very sensitive to fine details, is nevertheless verysensitive to small luminance differences on uniform zones.

4. *Zig-zag scan.* Except for the DC coefficient, which is treatedseparately, the 63 AC coefficients are read using a zig-zag scan(Fig. 3.6) in order to transform the matrix into a flow of databest suited for the next coding steps (RLC/VLC).

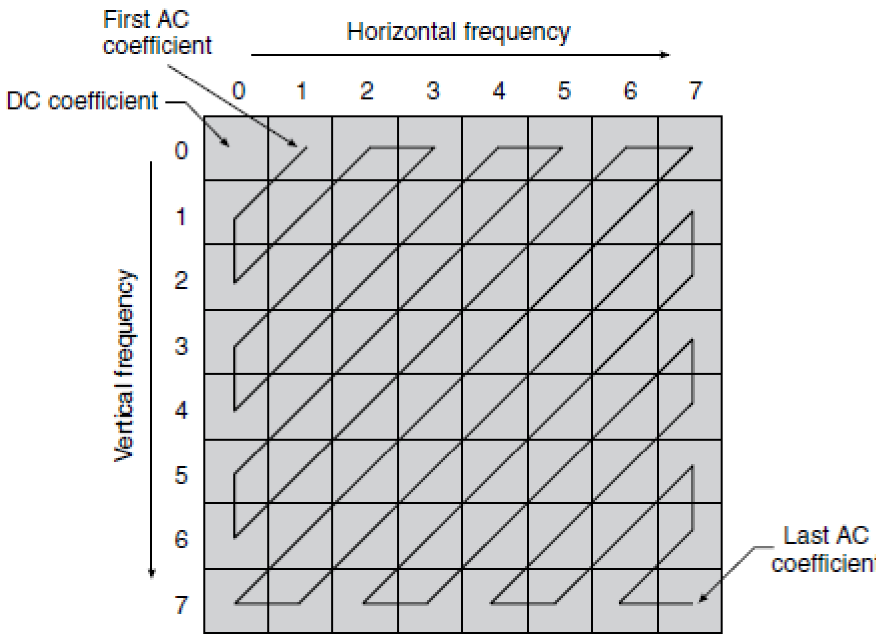


Figure 3.6 "Zig-zag" reading of the coefficients of the matrix.

5. *Run length coding.* In order to make the best possible use of thelong series of zeros produced by the quantization and the zigzagscan, the number of occurrences of zero is coded, followedby the next non-zero value, which reduces the amount of informationto transmit.

6. *Variable length coding (Huffmann coding).* This last step uses aconversion table in order to encode the most frequently occurringvalues with a short length, and the less frequent values with a longer one. These last two steps (RLC and VLC) aloneensure a compression factor of between 2 and 3.

The simplified principle of a JPEG decodercan be seen in the block diagram in Figure 3.7.

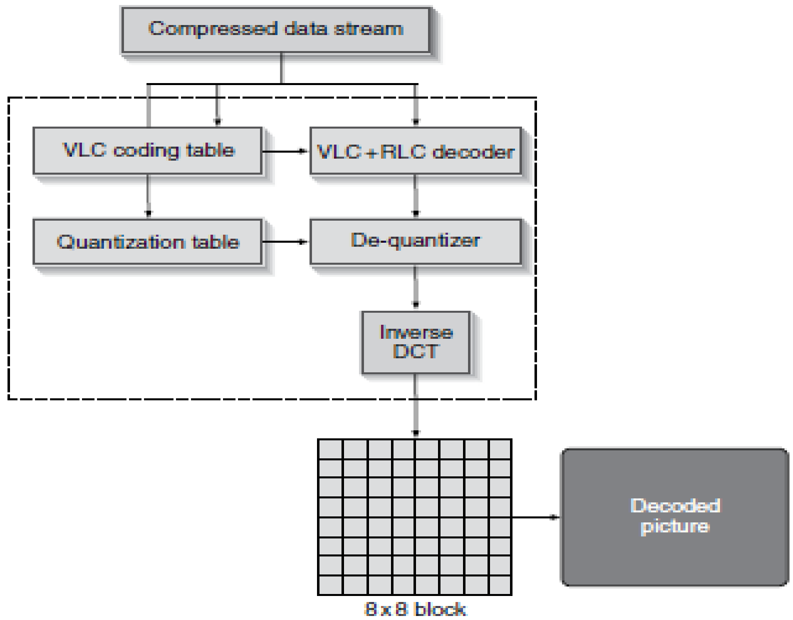


Figure 3.7 Principle of JPEG decoding.

Modulation

Once the source coding operations and the channel coding have been carried out, we have a data stream ready to be used for modulation of a carrier for transmission to the end users. Depending on the medium (satellite, cable, terrestrial network), the bandwidth available for transmission depends on technical and administrative considerations. signal-to-noise ratio and echoes—vary considerably between signals coming from a satellite, those from a cable network and those from a terrestrial transmitter where conditions can vary a great deal,

- for a *satellite* reception, the signal-to-noise ratio can be very small (10dB or less) butthe signal hardly suffers from echoes.
- by contrast, for *cable* reception, the SNR is quite strong (generally more than 30 dB), but the signal can be affected by echoes due to impedance mismatches in the network.
- in the case of *terrestrial* reception, conditions are more difficult, especially if mobile reception with very simple antennas is required (variable echoes due to multipath, interference, important signal level variations).

This is why modulation techniques have to be different, so that theycan be optimized for the specific constraints of the transmissionchannel and for compatibility with existing analog transmissions:

• on satellite, the channel width is generally between 27 and36 MHz, because of the need to use frequency modulation (FM)for transmission of an analog TV program (bandwidth 6–8MHz with associated sound carriers), due to the low CNR previouslydescribed;

• on cable or terrestrial networks, the channel width varies from6 (United States) to 7 or 8MHz (Europe) due to the use of AMwith a vestigial sideband (**VSB**) for video and one or more audio carriers.

Quadrature modulations

In the simplest digital modulation schemes, the carrier is directly modulated by the bitstream representing the information to be transmitted, either in amplitude (**ASK**, amplitude shift keying) or in frequency (**FSK**, frequency shift keying). However, the low spectral efficiency of these modulations makes them inappropriate for the transmission of high bit-rates on channels with a bandwidth which is as small as possible. In order to increase the spectral efficiency of the modulation process, different kinds of quadrature amplitude modulations (**QAM**) are used.

Figure 7.3 represents schematically the process of quadrature modulation and demodulation. Input symbols coded on n bits are converted into two signals I (in-phase) and Q (quadrature), each coded on n/2 bits, corresponding to 2n/2 states for each of the two signals.

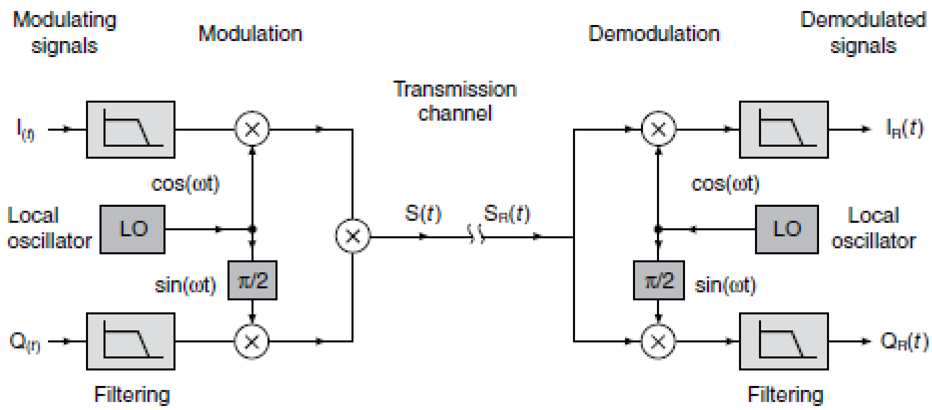


Figure 7.3 The basic quadrature modulation/demodulation process.

After digital-to-analog conversion (**DAC**), the I signal modulates an output of the local oscillator and the Q signal modulates another output in quadrature with the first (out of phase by _/2). The result of this process can be represented as a **constellation** of points in the I, Q space, which represents the various values that I and Q can take. Table 7.2 gives the main characteristics and denomination of some quadrature modulation schemes as a function of the numberof bits for each of the I and Q signals.

Figures 7.4 show, the constellations of **QPSK** modulation (quadrature phase shift keying or 4-QAM). These figure represent the situation at the output of the modulator, where each point is well distinguished from its neighbors, so that there is no ambiguity concerning the symbol value at this level.

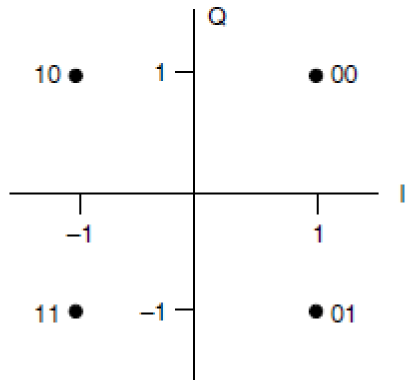


Figure 7.4 Constellation of a QPSK signal.

Table 7.2 Main characteristics of quadrature modulations

I/Q coding (bits)	Bits/symbol	No. of states	Abbreviation
1	2	4	QPSK (= 4-QAM)
2	4	16	16-QAM
3	6	64	64-QAM
4	8	256	256-QAM

COMPRESSION OF FRAMES

Video compression:

-is used to greatly reduce the bit rate
-reduces spatial redundancy within a frame and temporal redundancy between frames

1. **Spatial (intra-frame) compression:**

    - ✓ Compression takes place on each individual frame of the video treated as bitmapped image.
    - ✓ Spatial redundancy exists in each frame as in images
    - ✓ Based on quantization of DCT coefficients.
    - ✓ Compressing the pixel information as though it were a still image.
    - ✓ Can be lossless or lossy

2. **Temporal (inter-frame) compression:**

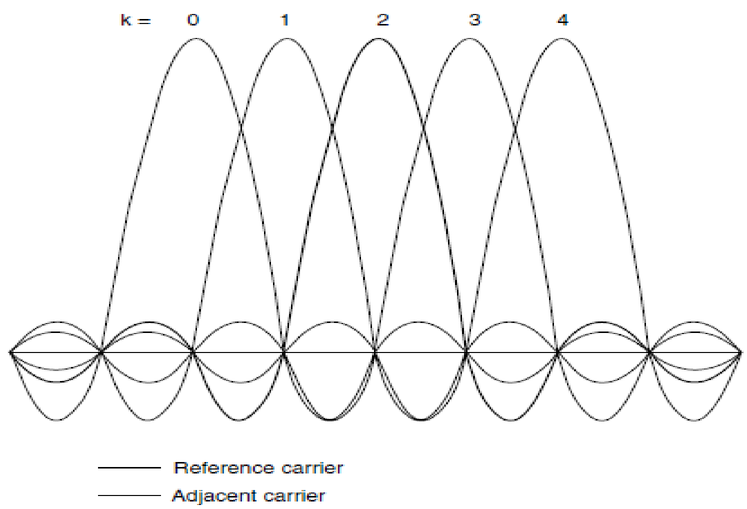
    - ✓ Compresses sequences of frames by only storingdifferences between them.
    - ✓ Temporal redundancy exists between frames
    - ✓ Predictive Encoding between frames in the temporal domain
    - ✓ Based on Motion Compensation (MC).
    - ✓ Most powerful compression
    - ✓ Compression happens over a series of frames and takes advantage of areas of the image that remain unchanged from frame to frame, throwing out data for repeated pixels
    - ✓ Key frames(selected frames) are spatially compressed only

OFDM FOR TERRESTRIAL DIGITAL TV (DVB –T)

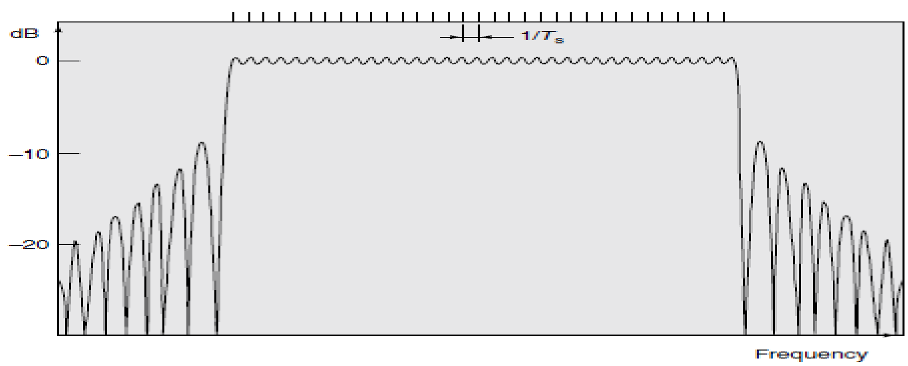
- Digital Video Broadcasting – Terrestrial system (DVB-T) defined by OFDM.

- The principle behind this type of modulation involves the distribution of a high rate bit stream over a high number of orthogonalcarriers each carrying a low bit-rate.

- OFDM modulation (orthogonal frequency division multiplexing) consists of modulating with symbols of duration Ts with a high number of carriers with a spacing of 1/Ts between two consecutive carriers.



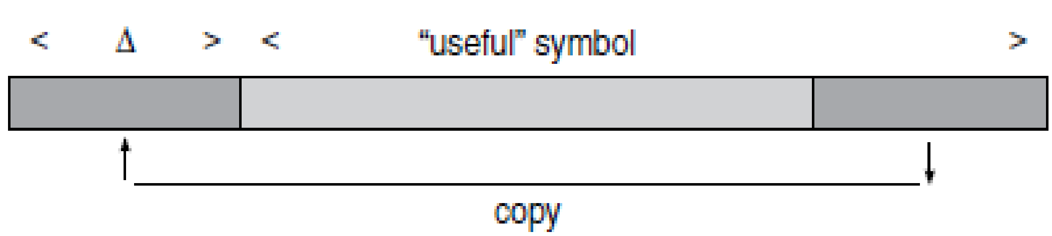
The frequency domain representation is given by:



- The relationship between the frequency f0 of the lowest carrier and that of carrier k, fk , is given by fk = f0 + k/Ts.

- The frequency spectrum of such a set of carriers shows secondary parasitic lobes of width 1/Ts

- In real terrestrial receiving conditions, signals coming from multiple indirect paths added to the direct path mean that the condition of orthogonality between carriers is no longer fulfilled, which results in inter-symbol interference. This problem can be avoided by adding a guard interval before the symbol period Ts in order to obtain a new symbol period Ns=Δ +Ts. This guard interval is generally equal to or less than Ts/4.



Types

- **2 K Mode:**The DVB uses an OFDM modulation with 2048 carriers (2 K)

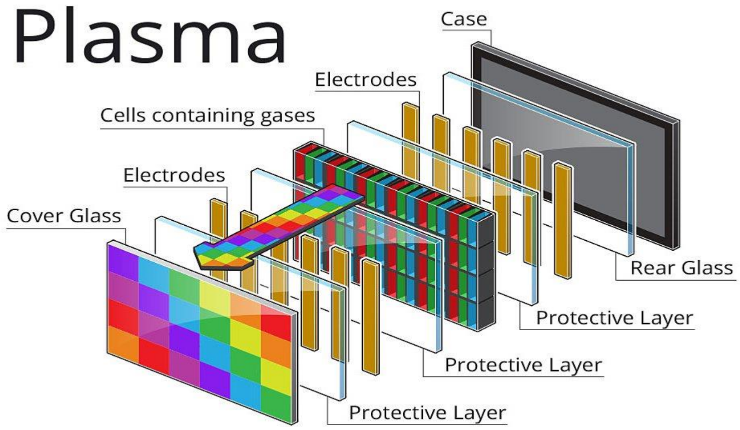
- **8 K Mode:**The DVB uses an OFDM modulation with 8192 carriers(8 K), for which the spectrum can be considered as virtually rectangular

DISPLAY TECHNOLOGIES: BASIC WORKING OF PLASMA, LCD AND LED DISPLAYS

Plasma. The central element in a fluorescent light is plasma, a gas made up of free flowing ions and electrons. Under normal conditions a gas is mainly made up of uncharged particles where individual gas atoms have equal number of protons and electrons which balance each other so that the atom has a net zero charge. If many free electrons are introduced into the gas by establishing an electronic voltage across it, the situation changes very quickly. The free electrons collide with the atoms knocking loose other electrons. With a missing electron, an atom loses its balance to become an ion with a net positive charge. In the plasma thus created with electric current flowing through it, negatively charged particles rush towards its positively charged area and positively charged particles move towards the negatively charged area. In this mad rush, particles are constantly bumping into each other. These collisions excite gas atoms in the plasma, causing them to release photons of energy in the form of ultraviolet light. The ultraviolet photons cause the release of visible light photons that illuminates the display.

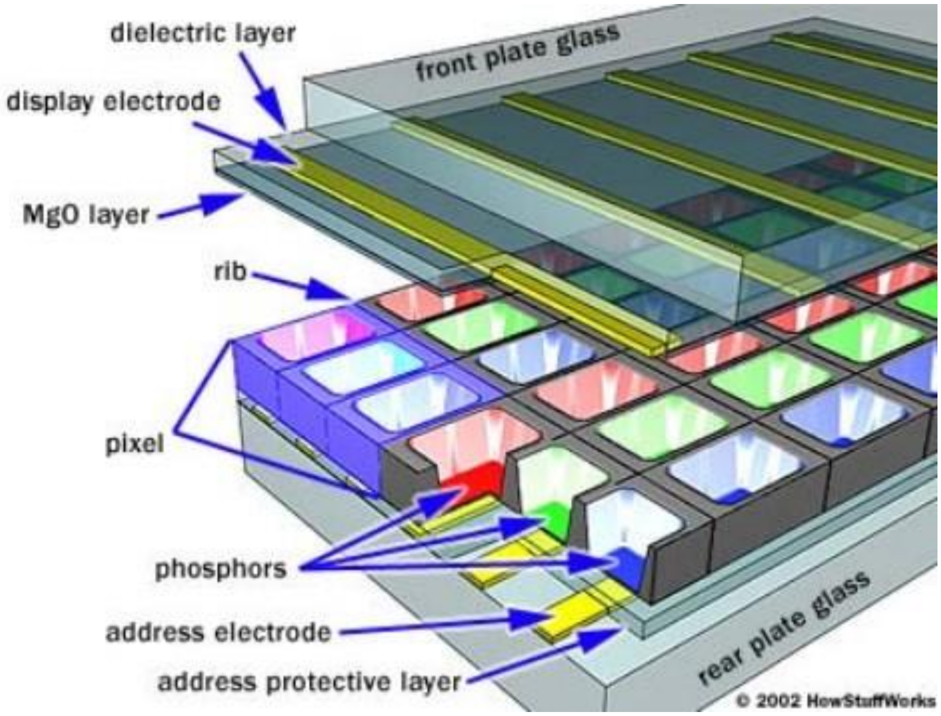
PLASMA TELEVISION SCREENS

Xenon or Neon gas atoms are used in plasma screen televisions. The gas is contained in hundreds of thousands of tiny cells positioned between two plates of glass. Long electrodes are also sandwiched between the glass plates on both sides of the cells. The address electrodes are behind the cells along the rear glass plate. The transport display electrodes which are surrounded by an insulating dielectric material and covered in a magnesium oxide protective layer are mounted above the cell along the front glass plate. Both sets of electrodes extend across the entire screen. The display electrodes are arranged in horizontal rows along the screen and the address electrodes in vertical columns. As shown in Fig. 32.3,



To ionize the gas in a particular cell, the plasma display's computer charges the electrodes that intersect at that cell. The computer does so thousands of times in a small fraction of a second charging each cell in turn. When the intersecting electrodes are charged on application of a small voltage, an electric current flows through the gas in the cell. As explained earlier, the current creates a rapid flow of charged particles which simulate the gas atoms to release ultraviolet photons. The released ultraviolet photons interact with phosphor material coated on the inside "wall of the cell. When an ultraviolet photon hits a phosphor atom in the cell, one of its electrons jumps to a higher energy level and the atom heats up. When the electron falls back to its normal level, it releases energy in the form of visible light photon which illuminate the screen.

The phosphors in a plasma display give-off colour light when they are excited. Each pixel is made up of three separate subpixel cells with different colour (R, G, B) phosphors. Their colours blend to create the overall colour of the panel. By varying the pulses of current flowing through the cells, the control system can increase or decrease the intensity of each subpixel colour to create hundreds of different combinations of red, green and blue. In this way, the control system can produce colours across the entire visible spectrum. In television, the control system sends synchronized current pulses in accordance with the R, G and B video signals obtained on demodulating and processing the received channel signal. This results in colour pictures similar to those being televised at the transmitting station.



LCD Display

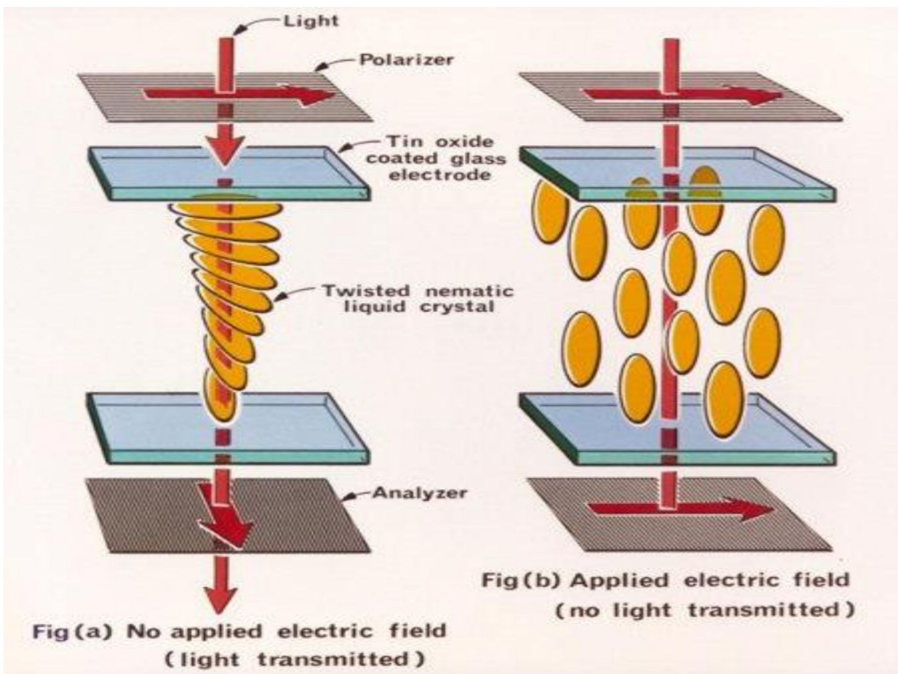
In solids, molecules always maintain their orientation and stay in the same position with respect to each other. In liquids, molecules change their orientation and move anywhere in the liquid. However, there are some substances where the molecules tend to maintain their orientation like in solids but move around to different locations as in liquids. These are called liquid crystals.

The procedure for creating a basic LCD starts with the selection of two pieces of polarized glass. A special Polymer that creates microscopic grooves in the glass surface is rubbed on the side of each selected glass piece. It is ensured that the grooves are in the same direction as the polarizing film. Next, a coating of Nemetic liquid crystals is added over the polymer to one of the glass filters. The grooves will cause its first layer of molecules to align with the filter's orientation. Then the second piece of glass is added with its polarizing film at right angles to the first piece. Each successive layer of nemetic crystal molecules will gradually twist until the uppermost layer is at 90 degree angle to the bottom, matching the polarized glass filters.

Operation.

As any incident light strikes the first glass filter it is polarized. The molecules in each layer of the applied nematic crystals then guide the light they receive to the next layer. As the light passes through the liquid crystal layers, its molecules also change the light's plane of vibrations to match their own angle. When light reaches the far side of the liquid crystal substance, it vibrates at the same angle as the final layer of molecules. If the final layer is matched up with the second polarized glass filter then the light will pass through.

If an electric charge is applied to liquid crystal molecules they untwist. On straightening out they change the angle of light passing through them so that it no longer matches the angle of the top polarized filter. Consequently, no light can pass through that area of the LCD, which makes it darker than the surrounding areas. If the glass panel is divided into a large number of sections insulated from each other, the nature of applied charge applied to them will produce either dark or light areas. Insulating electrodes are added to the panel for making connections to various sections. Fig. shows how various electrodes and liquid crystals are laid for the operation of LCD panels.



LCD SCREENS FOR TELEVISION

If voltage applied to a liquid crystal is carefully controlled, it can be made to partially untwist to allow some light to pass through it. By doing this in exact and very small increments, LCDs can create a grey scale that varies from full brightness to darkness. Most displays as also in television create 256 levels of brightness per pixel. An LCD that can show colours must have three sub-pixels each with red, green or blue filter to create one colour pixel. By careful control of the intensity of applied voltage to each subpixel, a range of 256 colour shades can be obtained which is enough to display full spectrum of visible light.

Advantages of an LCD's:

- LCD’s consumes less amount of power compared to CRT and LED
- LCD’s are consist of some microwatts for display in comparison to some mill watts for LED’s
- LCDs are of low cost
- Provides excellent contrast
- LCD’s are thinner and lighter when compared to cathode ray tube and LED

Disadvantages of an LCD’s:

- Require additional light sources
- Range of temperature is limited for operation
- Low reliability
- Speed is very low
- LCD’s need an AC drive

LED Display

Despite having a different acronym, an LED TV is just a specific type of LCD TV. The proper name would actually be “LED-backlit LCD TV,”. An LED TV uses a liquid crystal display (LCD) panel to control where light is displayed on your screen. These panels are typically composed of two sheets of polarizing material with a liquid crystal solution between them. When an electric current passes through the liquid, it causes the crystals to align so that light can (or can’t) pass through. Think of each crystal as a shutter, either allowing light to pass through or blocking it out.

Since both LED and LCD TVs are based around LCD technology.Older LCD TVs used cold cathode fluorescent lamps (CCFLs) to provide backlighting, whereas LED-backlit LCD TVs used an array of smaller, more efficient light-emitting diodes (LEDs) to illuminate the screen. As the technology is better, all LCD TVs now use LED lights and are colloquially considered LED TVs.

Backlighting

There are two basic forms of illumination that have been used in LED TVs: full-array LED backlighting and LED edge lighting. Each of these illumination technologies is different from one another in important ways.

Full-array backlighting

Full-array backlighting swaps the outdated CCFLs for an array of LEDs spanning the back of the LCD screen, comprising zones of LEDs that can be lit or dimmed in a process called local dimming. TVs using full-array LED backlighting make up a healthy chunk of the high-end TV market, and with good reason — with more precise and even illumination, they can create better picture quality than CCFL LCD TVs were ever able to achieve, with higher efficiency to boot.

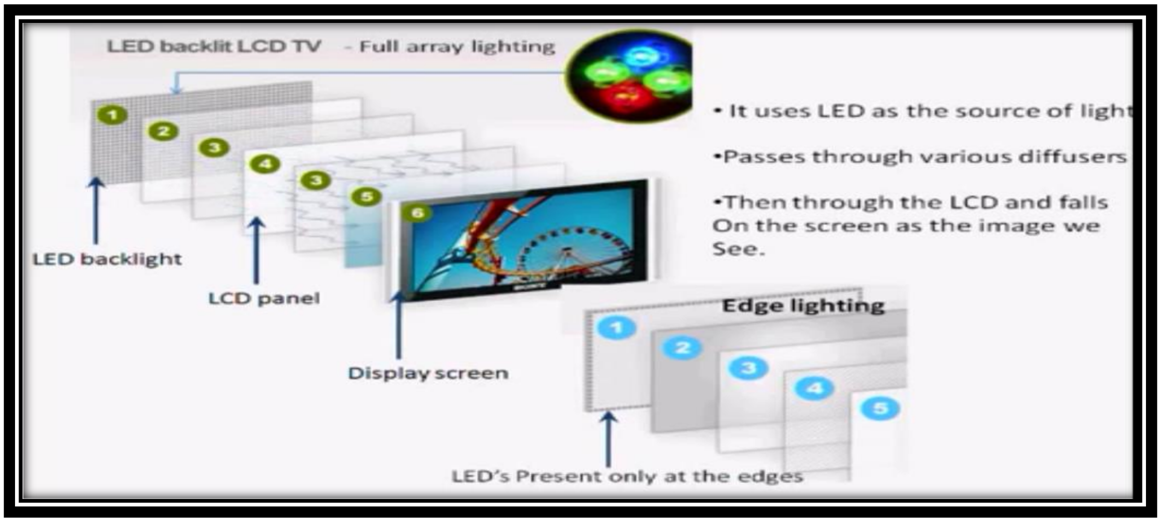
Edge lighting

Another form of LCD screen illumination is LED edge lighting. As the name implies, edge-lit TVs have LEDs along the edges of a screen. There are a few different such configurations, including LEDs along just the bottom, LEDs on the top and bottom, LEDs left and right, and LEDs along all four edges. These different configurations result in differences in picture quality, but the overall brightness capabilities still exceed what CCFL LCD TVs could achieve. While there are some drawbacks to edge lighting when compared to full-array or direct backlight displays, the upshot is edge lighting allows for manufacturers to make thinner TVs which cost less to manufacture.

Full-array and direct local backlighting Vs Edge lighting

TVs with full-array backlighting have the most accurate local dimming and therefore tend to offer the best contrast. Since an array of LEDs spans the entire LCD screen, regions can generally be dimmed with more finesse than on edge-lit TVs, and brightness tends to be more uniform across the entire screen. Vizio’s impressive P-Series and M-Series TVs are great examples of relatively affordable models that use multiple-zone, full-array backlighting with local dimming.

Because edge lighting employs LEDs positioned on the edge or edges of the screen to project light across the back of the LCD screen, as opposed to coming from directly behind it, it can result in very subtle blocks or bands of lighter pixels within or around areas that should be dark. As such, the local dimming of edge-lit TVs can sometimes result in some murkiness in dark areas when compared with full-array LED TVs. It should also be noted that not all LED edge-lit TVs offer dimming, which is why it is not uncommon to see glowing strips of light at the edges of a TV and less brightness toward the center of the screen.



Compression of moving pictures (MPEG)

In 1990, the need to store and reproduce moving pictures and theassociated sound in digital format for multimedia applications onvarious platforms led the ISO to form an expert group along the samelines as JPEG, with members coming from the numerous branchesinvolved; this group was called**MPEG** (Motion Pictures Experts Group).

The first outcome of its work was the International Standard ISO/IEC 11172, widely known as MPEG-1. The main goal was to allow thestorage on CD-ROM or CD-I of live videoand stereo sound, which implied a maximum bit-rate of 1.5 Mb/s.In addition to the intrinsic spatial redundancy exploited by JPEG forfixed pictures, coding of moving pictures allows exploitation of thevery important temporal redundancy between successive pictureswhich make up a video sequence.The format chosen for the pictures to beencoded is the SIF format, which corresponds roughly to the resolutionof a consumer video recorder.

MPEG standards

1. MPEG-1 is intended for intermediate data rates, on the order of 1.5 Mbit/sec.
2. MPEG-2 is intended for high data rates of at least 10 Mbit/sec.

3. MPEG-3 was intended for HDTV compression but was found to be redundant and was merged with MPEG-2.
4. MPEG-4 is intended for very low data rates of less than 64 Kbit/sec.

COMPRESSION OF MOVING PICTURE -MPEG

The MPEG compression algorithm encodes the data in 5 steps

1. ***First a reduction of the resolution is done***

The resolution is reduced bySIF format. It is obtained by halving the spatial resolution in both directions as well as the temporal resolution, which becomes 25 Hz for 625-line systems and 29.97 Hz for 525-line systems. Depending on the originating standard, the spatial resolutions are then:

• luminance resolution: 360×288 (625 lines) or 360×240 (525 lines);

• chrominance resolution: 180×144 (625 lines) or 180×120 (525 lines).

Figure 2.5 illustrates the position of the samples in the SIF format. Horizontal resolution is obtained by filtering and sub-sampling the input signal. The reduction in temporal and vertical resolution is normally obtained by interpolating samples of the odd and even fields, but is sometimes achieved by simply dropping every second field of the interlaced input format. The resolution obtained is the base for MPEG-1 encoding, and is resulting in a so-called "VHS-like"quality in terms of resolution.

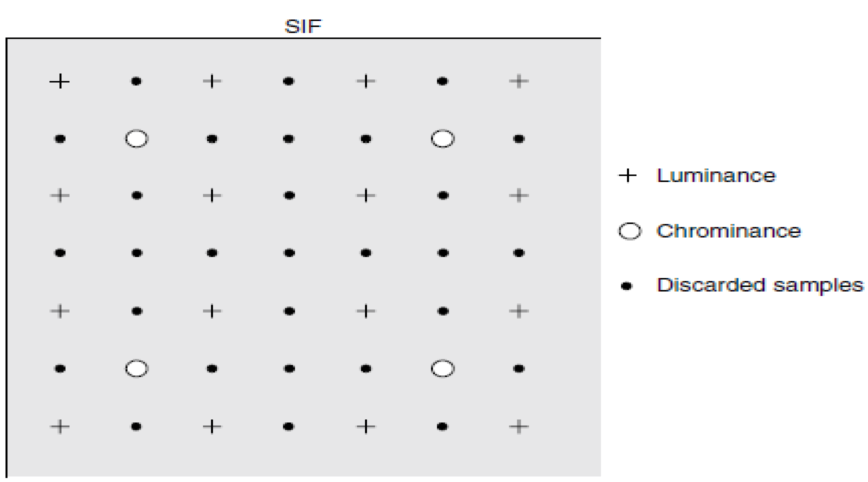


Figure 2.5 Position of samples in the SIF format.

2. ***Motion compensation in order to reduce temporal redundancy***.

In the field of video compression; a video frame is compressed using different algorithms with different advantages and disadvantages, centered mainly around amount of data compression. These different algorithms for video frames are called picture types or frame types. The three major picture types used in the different video algorithms are I, P and B. They are different in the following characteristics:

- **I-frames**(**intracoded frame**) are the least compressible but don't require other video frames to decode.

- ✓ I-frame is an independent frame that is not related to any other frame.
- ✓ They are present at regular intervals.
- ✓ An I-frame must appear periodically to handle some sudden change in the frame that the previous and following frames cannot show. Also when a video is broadcast, a viewer may tune at any time.
- ✓ If there is only one I-frame at the beginning of the broadcast, the viewer who tunes in late will not receive a complete picture.
- ✓ I-frames are independent of other frames and cannot be constructed from other frames.

- **P-frames**(**predicted frame**)can use data from previous frames to decompress and are more compressible than I-frames.

- ✓ P-frame is related to the preceding I-frame or P-frame.
- ✓ In other words, each P-frame contains only the changes from the preceding frame.
- ✓ The changes cannot cover a big segment.
- ✓ For example, for a fast-moving object, the new changes may not be recorded in a P-frame.
- ✓ P-frames can be constructed only from previous I- or P-frames.
- ✓ P-frames carry much less information than other frame types and carry even fewer bits after compression.

- **B-frames**(**bidirectional frame**) can use both previous and forward frames for data reference to get the highest amount of data compression.

- ✓ B-frame is related to the preceding and following I-frame or P-frame .
- ✓ In other words, each B-frame is relative to the past and the future.
- ✓ B-frame is never related to another B-frame.

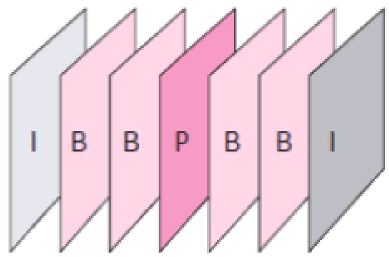
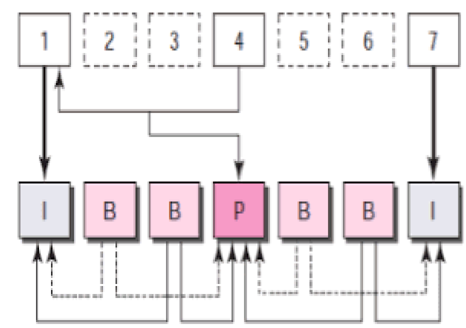


Fig1: MPEG frames



MPEG Frame Construction

Successive video frames may contain the same objects (still or moving). ***Motion estimation*** examines the movement of objects in an image sequence to try to obtain vectors representing the estimated motion. Motion compensation uses the knowledge of object motion so obtained to achieve data compression. In interframe coding, motion estimation and compensation have become powerful techniques to eliminate the temporal redundancy due to high correlation between consecutive frames.

In real video scenes, motion can be a complex combination of translation and rotation. Such motion is difficult to estimate and may require large amounts of processing. However, translational motion is easily estimated and has been used successfully for motion compensated coding.

3. The next steps are the Discrete Cosine Transformation (DCT)

A **discrete cosine transform** (**DCT**) expresses a finite sequence of data points in terms of a sum of cosine functions oscillating at different frequencies. DCT-based encoding algorithms are always lossy by nature. DCT algorithms are capable of achieving a high degree of compression with only minimal loss of data. This scheme is effective only for compressing continuous-tone images in which the differences between adjacent pixels are usually small.

4. ***A quantization as it is used for the JPEG compression- this reduces the spatial redundancy (referring to human visual perception).***

Quantize each block of DCT coefficients using weighting functions optimized for the human eye. Each of the transformed components in the data unit is divided by a separate number called its 'Quantization Coefficient (QC)' and then rounded to an integer. Large QC cause more loss. In general, the most MPEG implements allow use QC tables recommended by the MPEG standard.

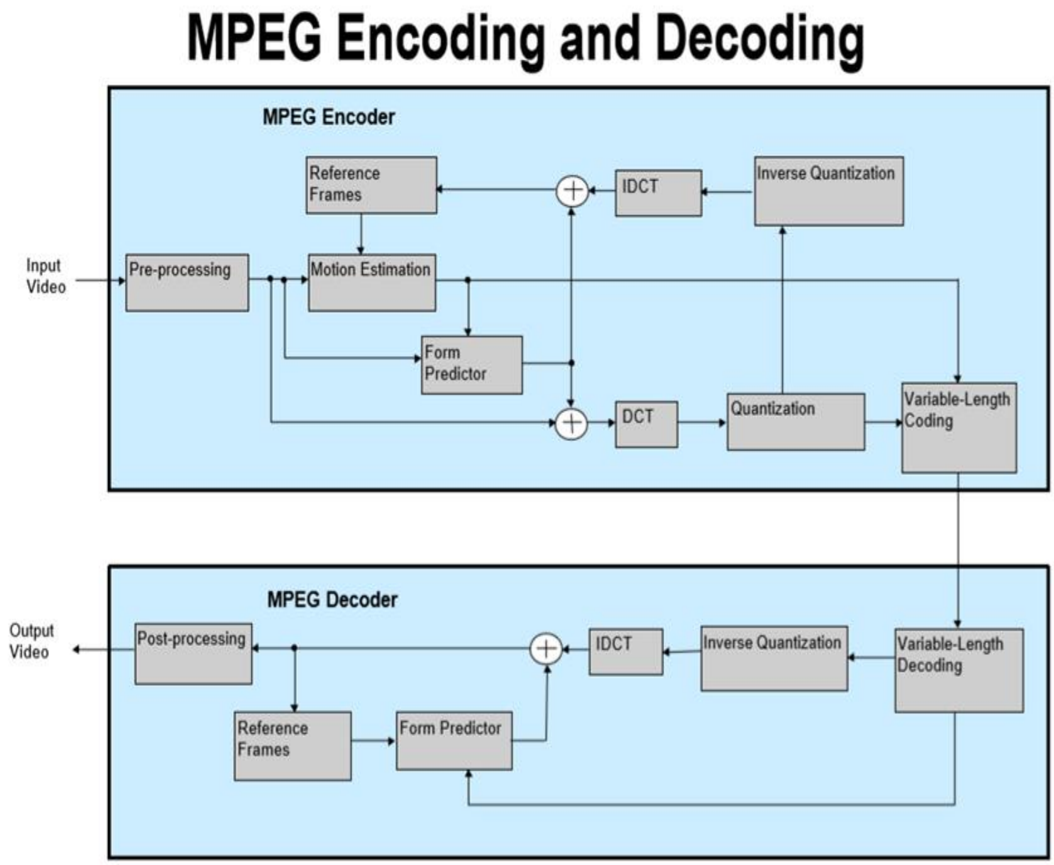
Separate quantization tables are employed for luminance and chrominance data with the chrominance data being quantized more heavily than the luminance data. This allows MPEG to exploit further the eyes differing sensitivity to luminance and chrominance. The compressor starts from a built in table that is appropriate for a medium quality setting and increase or decrease the value of each table entry in inverse proportion to the requested quality.

Quantization is performed by taking each of the 64 *frequency* values of the DCT block, dividing them by the frame-level quantizer, then dividing them by their corresponding values in the quantization matrix. Finally, the result is rounded down. This significantly reduces, or completely eliminates, the information in some frequency components of the picture. Typically, high frequency information is less visually important, and so high frequencies are much more *strongly quantized* (drastically reduced). MPEG-1 actually uses two separate quantization matrices, one for intra-blocks (I-blocks) and one for inter-block (P- and B- blocks) so quantization of different block types can be done independently, and so, more effectively.This quantization process usually reduces a significant number of the *AC coefficients* to zero, (known as sparse data) which can then be more efficiently compressed by entropy coding (lossless compression) in the next step.

5. The final step is an entropy coding using the Huffman coding algorithm.

The coefficients of quantized DCT blocks tend to zero towards the bottom-right. Maximum compression can be achieved by a zig-zag scanning of the DCT block starting from the top left and using Run-length encoding techniques.

The DC coefficients and motion vectors are DPCM-encoded.



Run-length encoding (RLE) is a very simple method of compressing repetition. A sequential string of characters, no matter how long, can be replaced with a few bytes, noting the value that repeats, and how many times. RLE is particularly effective after quantization, as a significant number of the AC coefficients are now zero (called sparse data), and can be represented with just a couple of bytes. This is stored in a special 2-dimensional Huffman table that codes the run-length and the run-ending character.

Huffman Coding is a very popular method of entropy coding, and used in MPEG-1 video to reduce the data size. The data is analyzed to find strings that repeat often. Those strings are then put into a special table, with the most frequently repeating data assigned the shortest code. This keeps the data as small as possible with this form of compression.Once the table is constructed, those strings in the data are replaced with their (much smaller) codes, which reference the appropriate entry in the table. The decoder simply reverses this process to produce the original data.

MPEG 2

- ✓ Jointly developed by ISO/IEC (IS 13818-2) and ITU-T (H.262)
- ✓ Permits data rates up to 10Mbps
- ✓ Supports interlaced video formats
- ✓ Supports HDTV
- ✓ Can be used for video over satellite, cable, and other broadband channels
- ✓ Backward compatibility with MPEG-1

MPEG-1 and MPEG-2

Parameter	MPEG-1	MPEG-2
Standardized	1992	1994
Main application	Digital video on CD-ROM	Digital TV (and HDTV)
Spatial resolution	SIF format (1/4 TV) 360x288 pixels	TV (4xTV) 720x576 (1440x1152)
Temporal resolution	25/30 frame/s	50/60 frame/s (100/120 fields/s)
Bit rate	1.5 Mbps	10Mbps (20 Mbps)
Quality	VHS	NTSC/PAL for TV
Compression ratio over PCM	20-30	30-40

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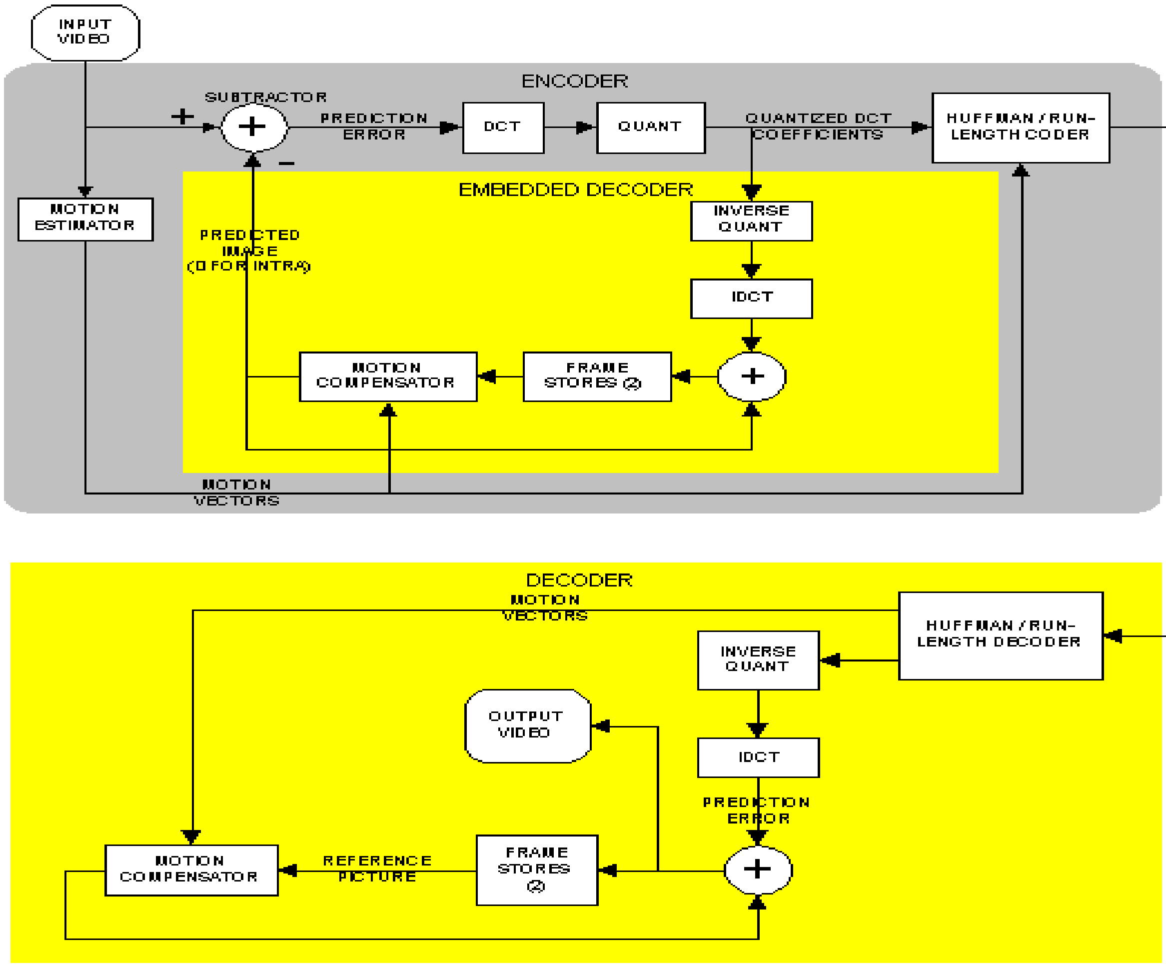
BASIC BLOCKS OF MPEG2 CODER AND DECODER



MPEG2 CODER

The input video frame to be encoded is giving to the motion estimator. ***Motion estimator*** examines the movement of objects in an image sequence to try to obtain vectors representing the estimated motion. The motion estimator uses block based coding for generating the motion vector. The video frame is divided into macro blocks and each macro block is compared with every macro block available in the database. If any match occurred, then the positional value of the macro block in the previous frame is giving as the output by motion estimator. This matching positional value is called motion vector.

Motion compensation uses the knowledge of motion vector to achieve data compression.***Motion compensation*** is an algorithmic technique employed in the encoding of video data for video compression. Motion compensation describes a picture in terms of the transformation of a reference picture to the current picture. The reference picture may be previous in time or even from the future. When images can be accurately synthesized from previously transmitted / stored images, the compression efficiency can be improved. The motion compensator, generates a predicted frame with the help of motion vector and previous frames which is available in the database.

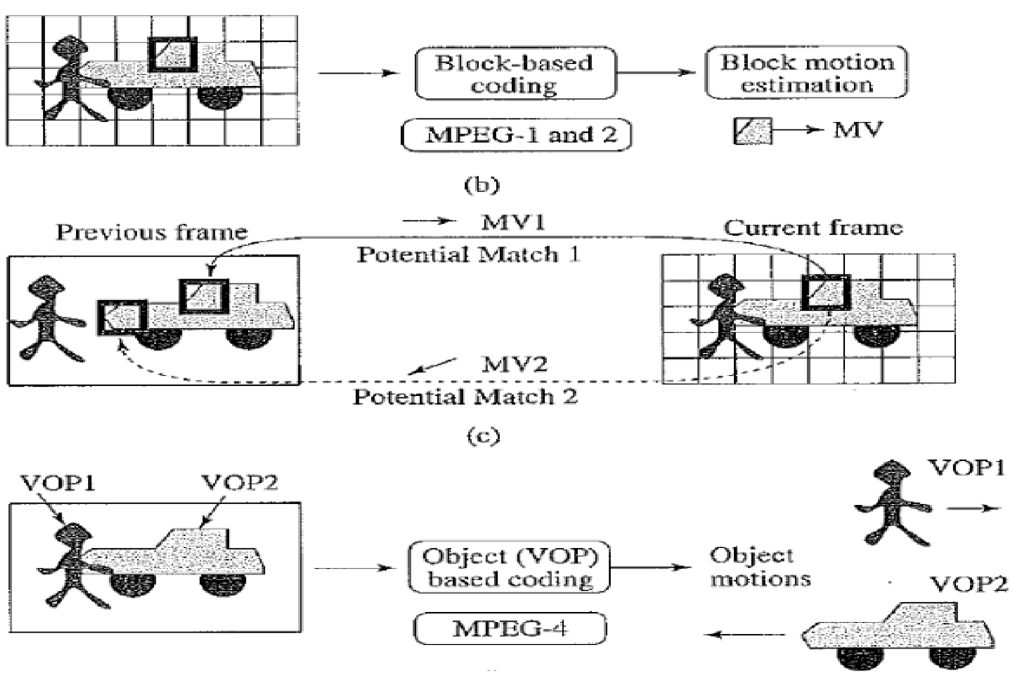
Now, the predicted frame is subtracted from current frame to be encoded to generate the prediction error.Then, the prediction error is transformed by DCT and quantized to generate the quantized DCT Co-efficient. The quantized coefficient along with motion vector as side information is then transmitted by encoding it with RLC and VLC (Huffaman coding). The quantized DCT Co-efficient goes through an inverse quantization and IDCT operation for regenerating the prediction error. When this error is adding with the output of motion compensator (predicted image), the original image is reproduced and retained in the database.

MPEG2 DECODER

Decoder performs the reverse operation of the encoder. The Huffman / RLC decoder is retrieving the quantized DCT Co-efficient and motion vector. The quantized DCT Co-efficient is used for recovering the prediction error by inverse quantization and IDCT. The motion vector is used forgenerating the predicted frame by motion compensation with the help of reference frames available in the database. If prediction error is added with predicted frame from the motion compensator, the original frame is getting recovered back. The original frame is stored in the database for future prediction operations.

<u>BASIC BLOCKS OF MPEG4 CODER AND DECODER</u>

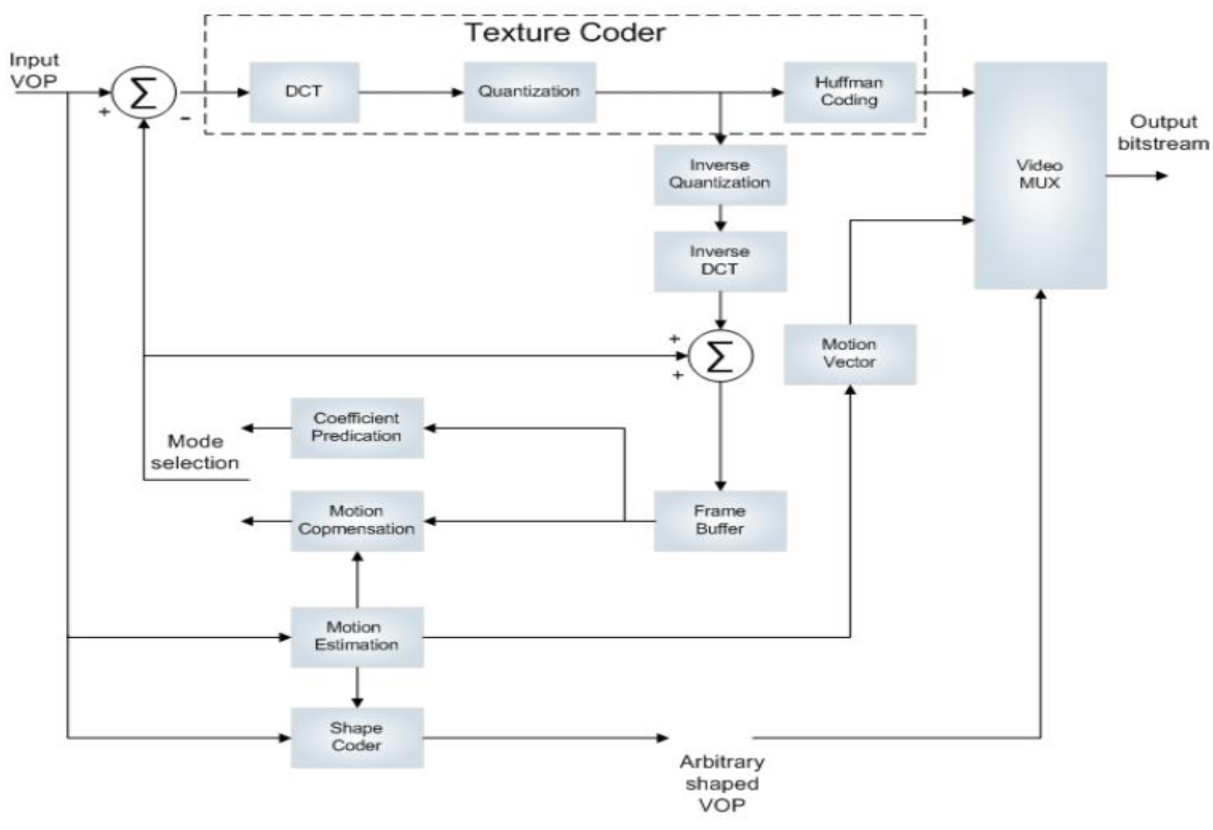
MPEG4 CODER



The above figure illustrates a possible example in which both potential matches yield small prediction errors. If Potential Match 2 yields a (slightly) smaller prediction error than potential Match 1, MV2 (Motion Vector 2) will be chosen as the motion vector for the macroblocks in the block - based coding approach, although only MV1(Motion Vector 1) is consistent with the vehicle's direction of motion.

Object - based coding in MPEG - 4 is aimed at solving this problem, in addition to improving compression. The figure shows each VOP is of arbitrary shape and will ideally obtain a unique motion vector consistent with the object's motion.

Motion compensation - based VOP (Video Object Plane) coding in MPEG - 4 again involves three steps: motion estimation, motion - compensation - based prediction, and coding of the prediction error. To facilitate motion compensation, each VOP is divided into many macroblocks, as in previous frame - based methods. Macroblocks are by default. 16 x 16 in luminance images and 8x 8 in chrominance images.MPEG - 4 defines a rectangular *bounding box* for each VOP.



The input video frame to be encoded is divided into number of VOP's and each VOP's are giving to the motion estimator and shape coder. ***Motion estimator*** examines the movement of objects in the VOP sequence to obtain vectors representing the estimated motion. The motion estimator uses object based coding for generating the motion vector. The VOP is divided into macro blocks and each macro block is compared with every macro block available in the database. If any match occurred, then the positional value of the macro block in the previous frame is giving as the output by motion estimator. This matching positional value is called motion vector.

Motion compensation uses the knowledge of motion vector to achieve data compression.***Motion compensation*** is an algorithmic technique employed in the encoding of VOP compression. Motion compensation describes a VOP in terms of the transformation of a reference VOP to the current VOP. The reference VOP may be previous in time or even from the future. When images can be accurately synthesized from previously transmitted / stored VOP, the compression efficiency can be improved. The motion compensator, generates a predicted VOP with the help of motion vector and previous VOP's which is available in the database.

Now, the predicted VOPis subtracted from current VOP to be encoded to generate the prediction error. Then, the prediction error is transformed by DCT and quantized to generate the quantized DCT Co-efficient. The quantized coefficient is encoding with RLC and VLC (Huffman coding) and giving to a video MUX. The motion vector transmitted to the decoder as side information is also giving to the MUX.

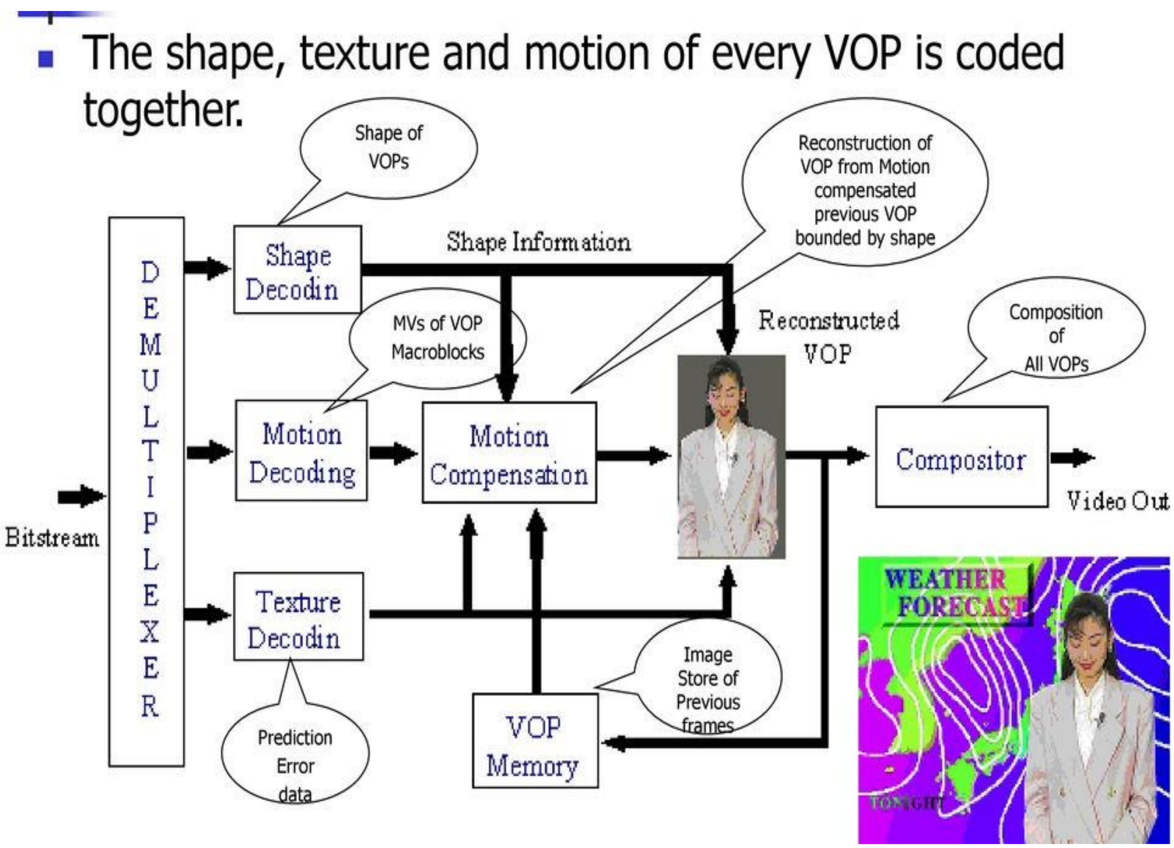
The difficulty in object based coding is that VOPs may have arbitrary shapes. Therefore, in addition to their texture, their shape information must now be coded. This can be done by a shape coder. The shape coder output is also giving to the MUX. The Video MUX will convert the texture coder information, motion vector information and shape coder information into an output bit stream and transmitted to the decoder side.

The quantized DCT Co-efficient corresponding to the texture coding goes through an inverse quantization and IDCT operation for regenerating the prediction error. When this error is adding with the output of motion compensator (predicted VOP), the original VOP is reproduced and retained in the database.

MPEG4 DECODER

Decoder performs the reverse operation of the encoder. From the encoder, the shape, texture and motion vector information are transmitting in a multiplexed form as bit streams. In the de-multiplexer, these information are de-multiplexed to get the coded information from the bit stream. These information are giving to separate decoder for motion vector decoding, texture decoding and shape decoding. The motion vector decoder will generate the motion vector of

VOP macroblock. The texture decoder will generate the prediction error data. The shape decoder will generate the shape information associated with the VOP.The motion vector of VOP, the prediction error data of VOP, the shape of VOP along with VOP's present in the database is used by the motion compensator for generating the reconstructedVOP. The reconstructed VOP is also stored in the database for future motion compensation. Finally, by using a compositor; composition of all VOP's are done to reconstruct the original video frame.



MPEG2 vs MPEG4

1. MPEG2 vs MPEG4 – Compression

The MPEG2 uses H.262 encoding while MPEG4 uses H.264. Though MPEG2's compression is much simpler than MPEG4

2. MPEG2 vs MPEG4 - File Size

MPEG2 encoded video files are much bigger compared to MPEG4.

3. MPEG2 vs MPEG4 – Quality

MPEG2 is superior to MPEG-4. MPEG2 is the industry standard and capable of handling video streams from local sources like DVDs and broadcast applications. On the other hand, MPEG4 utilizes its high rate of compression and smaller file sizes to provide high-quality video and audio across multimedia streaming applications on the Internet.

4. MPEG2 vs MPEG4 – Bit Rate & Bandwidth

MPEG2 format encoded files have a bitrate ranging from 5 to 80 Mbits/sec, while the MPEG4 files are substantially low relative to MPEG-2 .Therefore, MPEG4 format is designed for network applications.

5. MPEG2 vs MPEG4 bandwidth comparison

MPEG2 requires a lot more bandwidth for streaming compared to MPEG4. MPEG2 has a bandwidth of up to 40 MB per second, but MPEG4 has the bandwidth of around 64 kbps.

6. MPEG2 vs MPEG4 – Filename Extensions

MPEG2: .mpg, .mpeg, .m2v, .mp2, mp3 are some of a number of filename extensions used for MPEG-1 or MPEG-2 audio and video file formats.
MPEG4: .mp4, .m4a, .m4b, .m4r, .m4v are some file extensions of MPEG4 video/audio.

7. MPEG2 vs MPEG4 – Application

MPEG-2 is still used for DVDs and television broadcast, while MPEG4 is the encoding method of choice for portable devices and Internet streaming.