

Fundamental Concept of Video

By
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1. Introduction

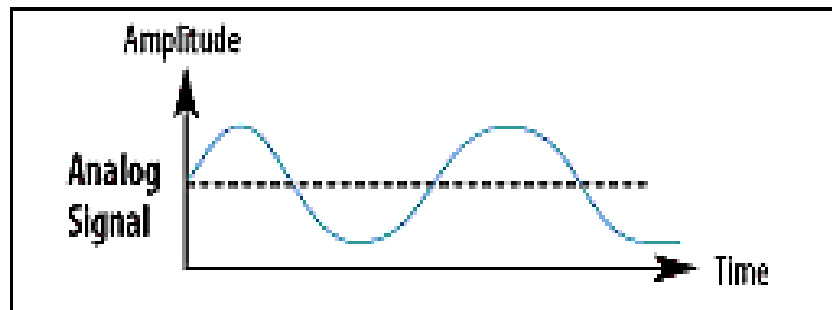
Video is the technology that captures moving images electronically. Those moving images are really just a series of still images that change so fast that it looks like the image is moving.

Video is an excellent tool for delivering multimedia because it contains all the components of multimedia (image, sound, and text). It is recorded from a live source.

2. Video standard

2.1. Analog Video

- Analog is the process of taking audio or video signal and translating it into electrical pulses. In an analog system, the output of the CCD (**Charge Coupled Devices**) is processed by the camera into three channels of color information and synchronization pulses (sync) and the signals are recorded onto magnetic tape.



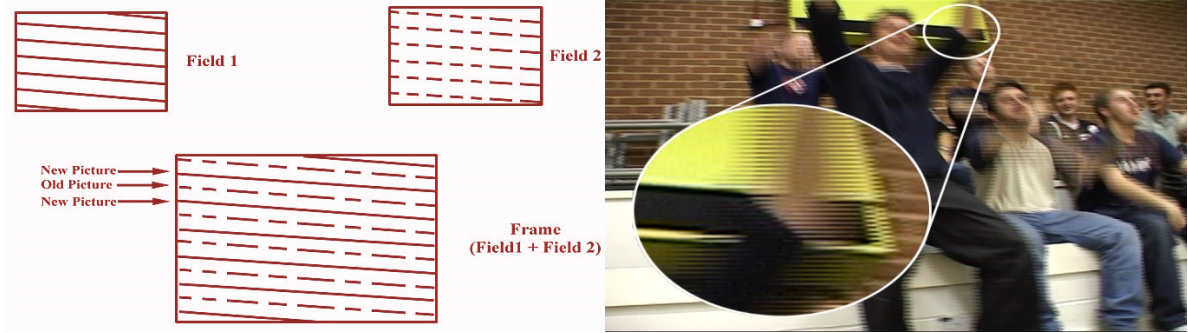
Three analog broadcast video standards are commonly in use around the world:

➤ **NTSC**

- National Television Standards Committee (NTSC).
- Used in United States, Japan, Canada and many other countries.
- a single frame of video was made up of 525 horizontal scan lines , first it laid down all the odd-numbered lines, and then all the even-numbered lines.
- Each of these passes painted a field, and the two fields were then combined to create a single frame.

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- In NTSC system for television and video, frames are displayed at a rate of 30 per second.



➤ PAL

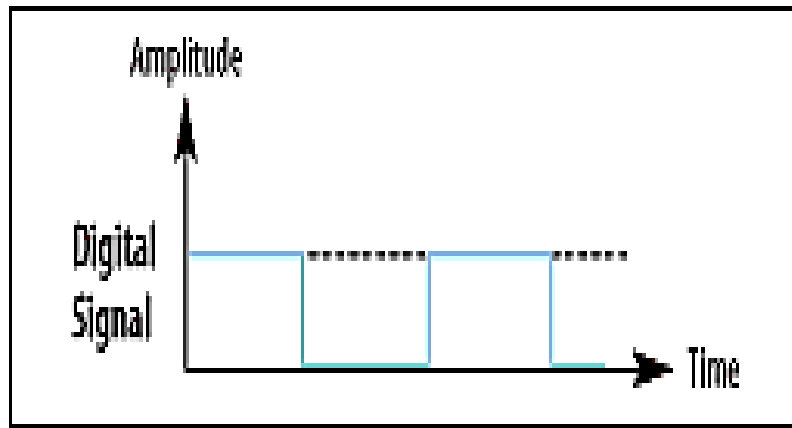
- Phase Alternating Line (PAL)
- Used in the United Kingdom, South Africa, China, and Australia.
- PAL increased the screen resolution to 625 horizontal lines.
- 25 frames per second.

➤ SECAM

- Sequential Color and Memory (SECAM)
- Used in France, Eastern Europe, and a few other countries.
- SECAM is a 625-line.
- 25 frames per second.

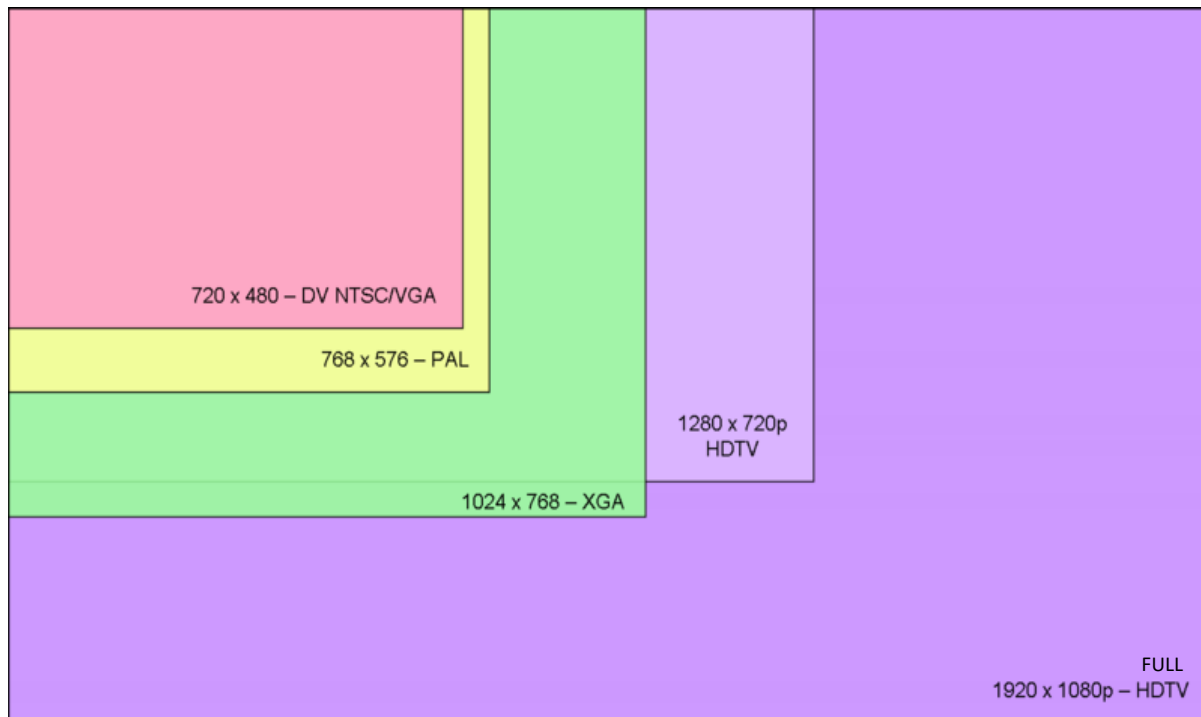
2.2. Digital Video

Digital video is a **sequence of picture signals (frames)** that are represented by binary data (bits) that describe a finite **set of color and luminance levels**. The digital information contains characteristics of the video signal and the position of the image (bit location) that will be displayed. The basic process of creating digital video is the image **digitization process, compression analysis that produces key frames and difference frames, and formatting the data into files or streams (video formats)**.



➤ HD

- High Definition formats.
- Here Modified the Digital format Standard and moved from an analog to a digital standard.
- HD frames may have width 720 x 1080 pixels.



3. The Main Difference Between the Digital and Analog Medium

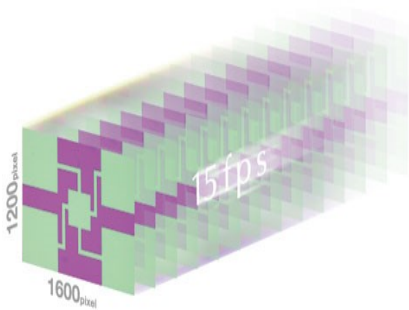
- ✚ In digital format Random Access enables us to quickly jump to any point in a movie. In analog format, we have to wind the tape backward and forward to reach a point in the movie.
- ✚ It is easy to duplicate digital video without loss of quality, were video producers can convert real-life video that they have shot into digital format and edit it without losing the original quality of the film. In the analog tapes, video producers lose some quality after the first time they edit the video.
- ✚ Digital format also allows us to quickly cut, paste, or edit video in other ways. It also allows easy addition of special effects.

4. Basic Concept of Video.

1- Bit Rate is amount of data that can be carried from one point to another in a given time period (usually a second). Bit rate is sometimes called data rate or transfer rate or bandwidth.

2- Aspect Ratio This is the ratio of width to height video will be encoded. This information is present in the output video stream and used by the decoder to display the video at the correct aspect ratio. The computer display is designed for an aspect ratio of 1.33:1, which means that the width of the display area is only 1.33 times the height, almost *square*.

3- Frame means one still picture. By changing still pictures (frames) quickly, human eye "thinks" that the video is smooth and can't separate pictures from each other's and instead sees smooth video.



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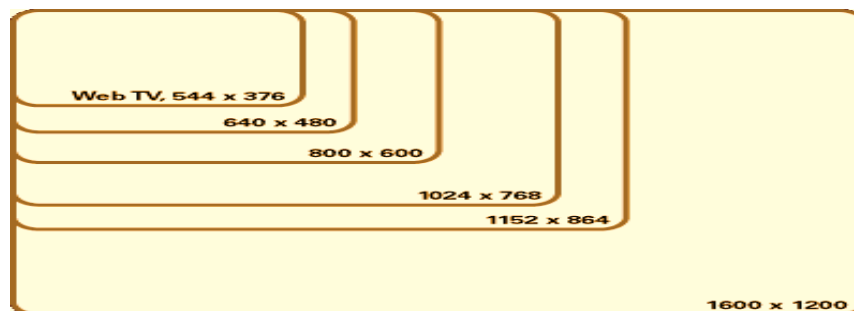
4- Frame Rate is the number of video frames (complete pictures) that will be presented to the viewer each second. Human eye can see smooth video with the frame rate more than ~24 fps (frames per second). The normal human eye sees 250 frames per second.

Number of Frame	Clarity and smoothness
5 or 10	Intermittent and non-smooth
24	smoothly without roughness (Cinematography)
30	smoothly without roughness (TV work)
≥ 60	Slow footage

5- Frame Buffer is a special memory to hold the complete digital representation of the frame to be displayed on a computer screen.

6- Color Depth or bit depth is the number of bits used to represent the color of a single pixel in a bitmapped image or video frame buffer. It is known as bits per pixel (bpp). The quality of video is dependent on the color quality.

7- Image Size a standard full screen resolution is 640x480 pixels . New high-definition televisions (HDTV) are capable of resolutions up to $1920 \times 1080p60$, 1920 pixels per scan line by 1080 scan lines, progressive, at 60 frames per second.



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8- File Size Several elements determine file size:

- Frame rate
- Image size
- Color depth

To determine file size use the following formula:

$$\text{File size} = \text{Frames Per Second (FPS)} * \text{image size} * \text{color depth} / 8$$

5. Types of Video Signals

Video signals can be organized in three different ways:

5.1. Component video

- Higher-end video systems make use of three separate video signals for the **red**, **green**, and **blue** image planes. Each color channel is sent as a separate video signal.
- Best color reproduction.
- Component video requires more bandwidth and good synchronization of the three components.

5.2. Composite Video (1 Signal)

Color (“chrominance”) and intensity (“luminance”) signals are mixed into a single carrier wave.

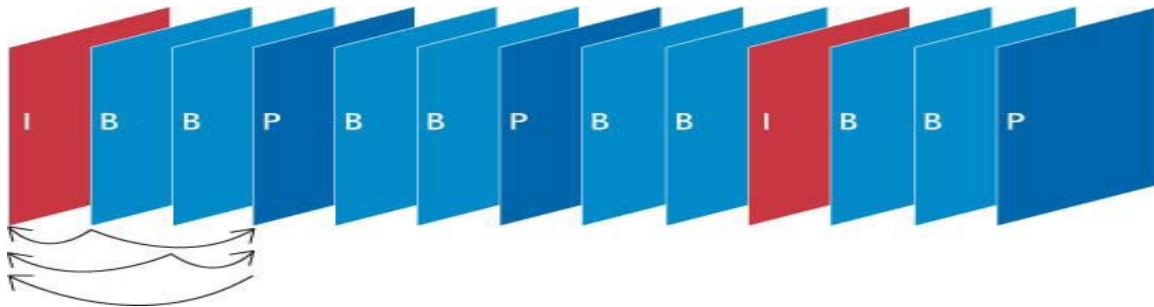
- a) **Chrominance** is a composition of two color components (I and Q, or U and V).
- b) The chrominance and luminance components can be separated at the receiver end and then the two color components can be further recovered.
- c) Since color and intensity are wrapped into the same signal, some interference between the luminance and chrominance signals is inevitable.

5.3. S-Video (2 Signals)

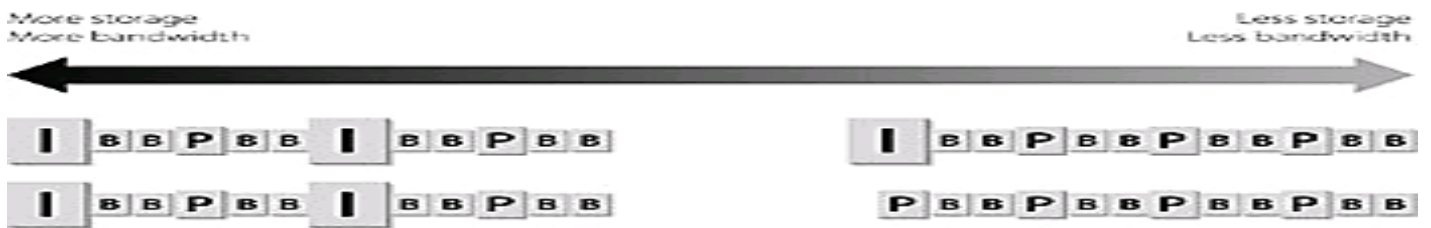
As a compromise, (**Separated video**, or **Super video**, e.g., in S-VHS) uses two wires, one for luminance and another for a composite chrominance signal. There is less crosstalk between the color information and the crucial gray-scale information.



6. Frames Types



- **I Frame (Intra Frame)** This is a type of key frame. Key frames derive directly from the video and are not calculated from other frames. I frames are the largest frames and must store the most data.
- **P Frame (Predictive Frame)** This frame is derived from the frame before it and specifies how it differs from the previous frame. P frames are smaller than I frames, requiring much less data storage. P frames are a type of difference frame. All difference frames are calculated from other frames, so they store much less data per frame.
- **B Frame (Bidirectional Frame)** This frame is computed from both the frames before and after it. B frames are the smallest of the three frame types. Like P frames, B frames are difference frames.



I = Intraframe (key frame)
P = Predictive frame (difference frame)
B = Bidirectional frame (difference frame)

7. Compression

Compression Is technique of reducing the amount of storage required to hold a digital file to reduce the disk space the file requires and allows it to processed and transmitted more quickly.

The techniques are employed to achieve desirable reductions in image data:

- Reduce color nuances within the image.
- Reduce the color resolution with respect to the prevailing light intensity.
- Remove small, invisible parts, of the picture.
- Compare adjacent images and remove details that are unchanged.

7.1. Video Compression

Refers to reducing the quantity of **data** used to represent **digital video image** two key compression factors into consideration:

Lossiness refers to a quality decrease produced by the compression process. It means that the picture you see when you decompress won't be exactly the same picture you originally compressed.

Time A compressed video needs to be restored (decompressed) to be viewed. It takes time—often a lot of it—to decompress your video.

- Used compression to reduce the redundancy there are two types:

1- **Temporal Redundancy** can be reduced by registering differences between frames (B and P frame).

2- **Spatial Redundancy** is reduced by registering differences between parts of a single frame (I- frames).

7.2. Types of Data Compression

There are two categories of data compression

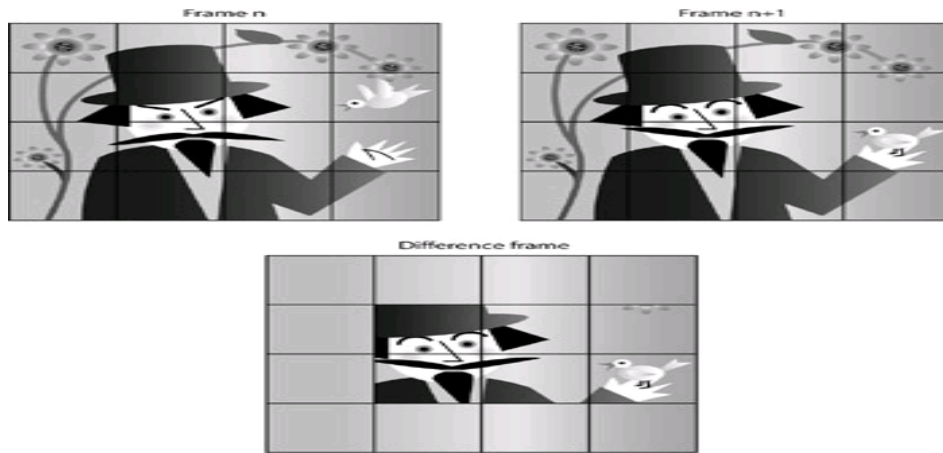
Lossy Compression: in which the compression processes remove some of the data.

Lossless Compression: the compression process allows for subsequent decompression of the data with no loss of the original data. Lossless compression is used for program.

7.3. Compression / Coding Standards

The various Motion Picture Experts Group (MPEG) formats are good examples of Intra frame and the table below summarize some common video compression format.

MPEG-1	MPEG-2	MPEG-4
Released in 1992	Released in 1994	Released in 1998
A standard for coded representation of Moving pictures, Audio, and Combination of above.	Used in NTSC/PAL with bit rates target between 2-10 Mbit/s, It also supports HDTV applications.	Algorithms and tools for coding and flexible representation of audio/video.
Typical application video CD (VCD).	Applications: Digital video tape recorder (VTR) , DVD.	Typical application in mobile phone and HDTV.
	key frame rates increase, so do image quality, storage, and bandwidth.	
	Dividing pictures into blocks and comperes. When successive blocks prove sufficiently dissimilar, the change is recorded onto a difference frame, either a B or P frame. <u>The difference frame stores only those parts of the picture that have changed.</u>	

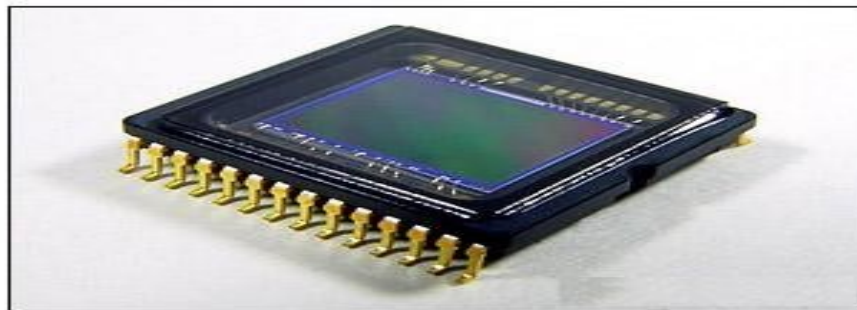


Compression in MPEG-2

8. Hardware for video capture

8.1. Digital Video camera

A digital video camera (camcorder) functions in the same way as a still digital camera. The user points the camcorder at the scene they wish to capture and a lens focuses the image onto an **array of CCDs (Charge Coupled Devices)** each CCD corresponds to one pixel in the image being recorded. The CCD is a sensor which changes the light striking it into an electrical signal.

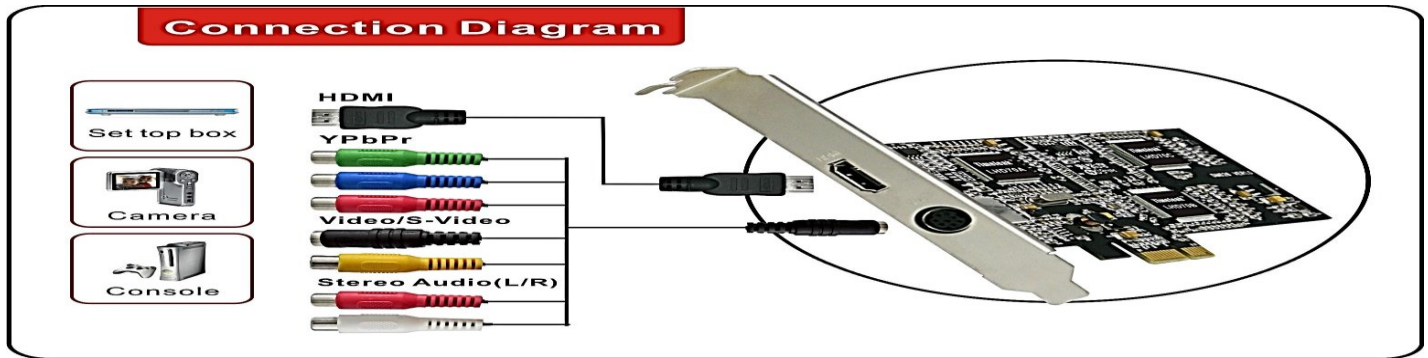


8.2. Webcams

- Are used for real-time chat, including instant messaging (IM), telephone calls over the internet, live broadcasts and video conferencing.
- Webcams are a lot less expensive than camcorders.
- There are fewer CCDs.
- They have no backing storage facility.

8.3 Video Capture Card

- If a recording was made with an analogue video camcorder then the conversion from analogue and compression will not have taken place.
- Receives the video data, converts it to digital and compresses it.
- Can be used to receive data from an analogue video recorder or analogue TV.



9. Advantages of Using Video

- ✚ Captures interest.
- ✚ Increase retention.
- ✚ Clarifies complex physical actions and relationships.
- ✚ Video is the most powerful communicative tool in history, it allow you to communicate your message quickly and effectively.
- ✚ With video, you can expect nearly 100% viewership.
- ✚ video presents standardized information for every viewer, every time can incorporate other media.

10. Disadvantages of Using Video

- ✚ Is expensive to produce.
- ✚ Requires extensive memory and storage.
- ✚ Requires special equipment.
- ✚ Does not effectively illustrate abstract concepts and static situations.