Images

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- Image Data Types
- File Formats
- Color Models in Images and Video
- Types of Video Signals
- Video Standards

Introduction to image processing 1.

What is an image?

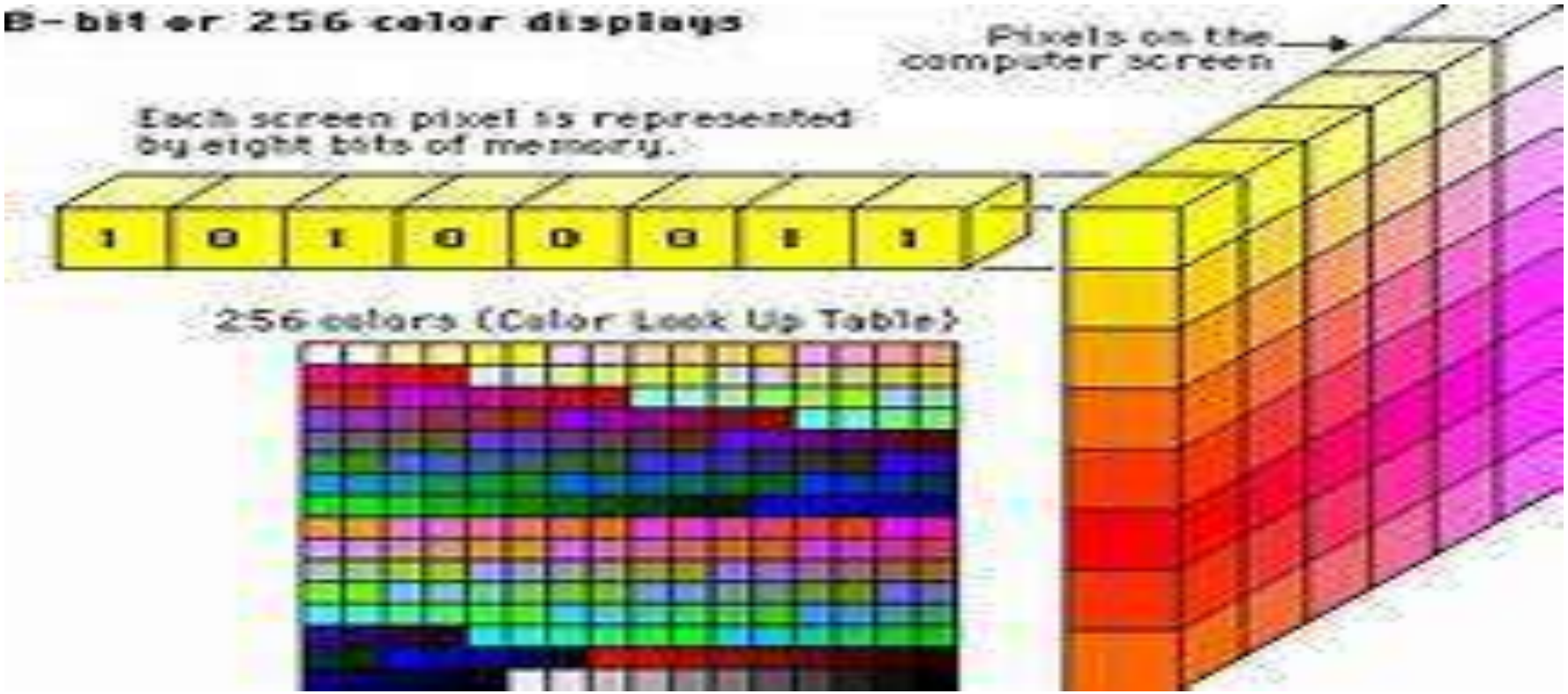
- An image is an array, or a matrix, of square pixels (picture elements) arranged in columns and rows. F



(8-BIT)

- In a (8-bit) greyscale image each picture element has an assigned intensity that ranges from 0 to 255. A grey scale image is what people normally call a black and white image, but the name emphasizes that such an image will also include many shades of grey.

  A normal greyscale image has 8 bit colour depth = 256 greyscales. A "true colour" image has 24 bit colour depth = 8 x 8 x 8 bits = 256 x 256 x 256 colours = ~16 million colours.


8-bit or 256 color displays
Pixels on the computer screen
Each screen pixel is represented by eight bits of memory.
1 0 1 0 0 0 1 1
256 colors (Color Look Up Table)

- Some greyscale images have more greyscales, for instance 16 bit = 65536 greyscales. In principle three greyscale images can be combined to form an image with 281,474,976,710,656 greyscales. There are two general groups of 'images': vector graphics (or line art) and bitmaps (pixel-based or 'images'). Some of the most common file formats are: GIF — an 8-bit (256 colour), non-destructively compressed bitmap format. Mostly used for web. Has several sub-standards one of which is the animated GIF. JPEG — a very efficient (i.e. much information per byte) destructively compressed 24 bit (16 million colours) bitmap format. Widely used, especially for web and Internet (bandwidth-limited). TIFF — the standard 24 bit publication bitmap format. Compresses nondestructively with, for instance, Lempel-Ziv-Welch (LZW) compression. PS — Postscript, a standard vector format. Has numerous sub-standards and can be difficult to transport across platforms and operating systems. PSD – a dedicated Photoshop format that keeps all the information in an image including all the layers.

24-bit Color Images

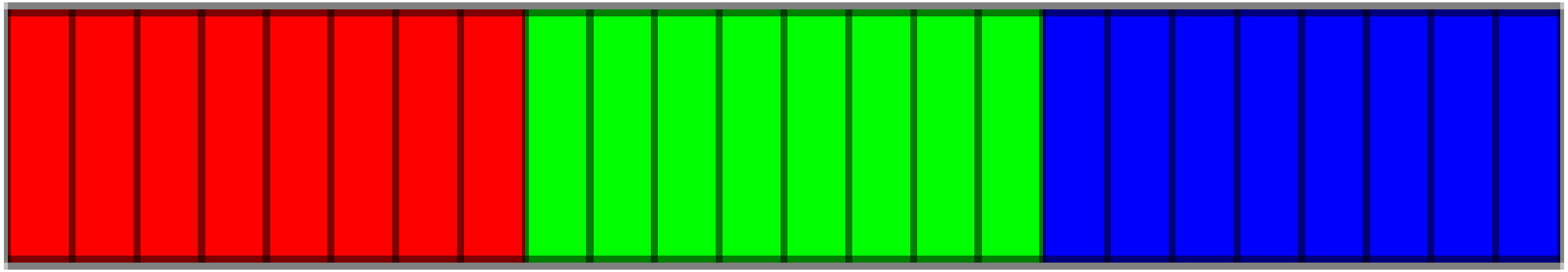
Full RGB color requires that the intensities of three color components be specified for each and every pixel. It is common for each component intensity to be stored as an 8-bit integer, and so each pixel requires 24 bits to completely and accurately specify its color. Image formats that store a full 24 bits to describe the color of each and every pixel are therefore known as *24-bit color images*.

Using 24 bits to encode color information allows different colors to be represented, and this is sufficient to cover the full range of human color perception fairly well.

The term 24-bit is also used to describe monitor displays that use 24 bits per pixel in their display memories, and which are hence capable of displaying a full range of colors.

There are also some disadvantages to using 24-bit images. Perhaps the main one is that it requires three times as much memory, disk space and processing time to store and manipulate 24-bit color images as compared to 8-bit color images. In addition, there is often not much point in being able to store all those different colors if the final output device (*e.g.* screen or printer) can only actually produce a fraction of them. Since it is possible to use colormaps to produce 8-bit color images that look almost as good, at the time of writing 24-bit displays are relatively little used. However it is to be expected that as the technology becomes cheaper, their use in image processing will grow

24 bit Color

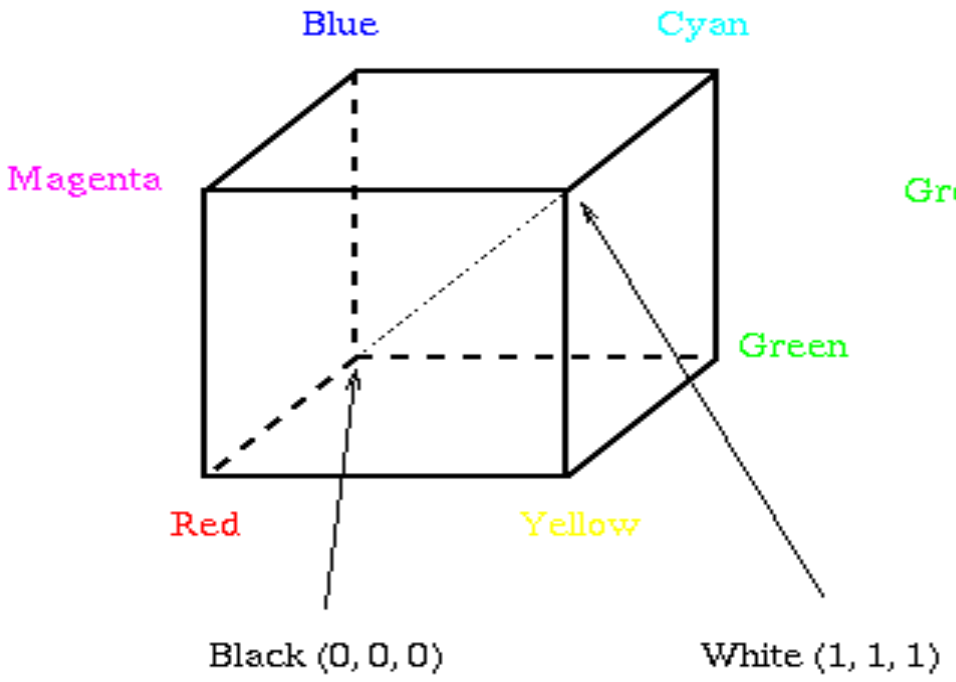


Red = 8 bits Green = 8 bits Blue = 8 bits

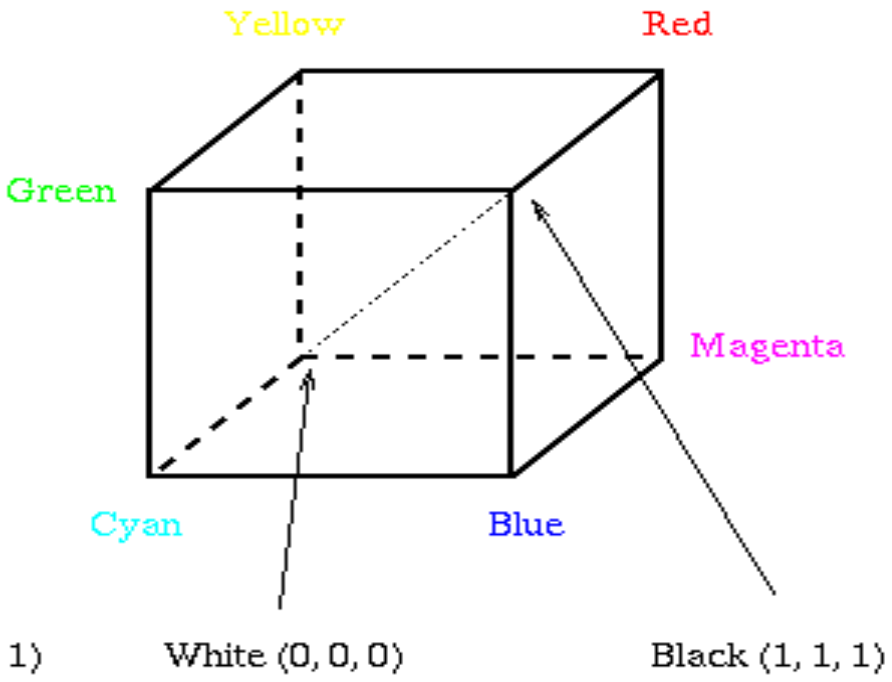
Colors models in images and videos

- For science communication, the two main colour spaces are RGB and CMYK.

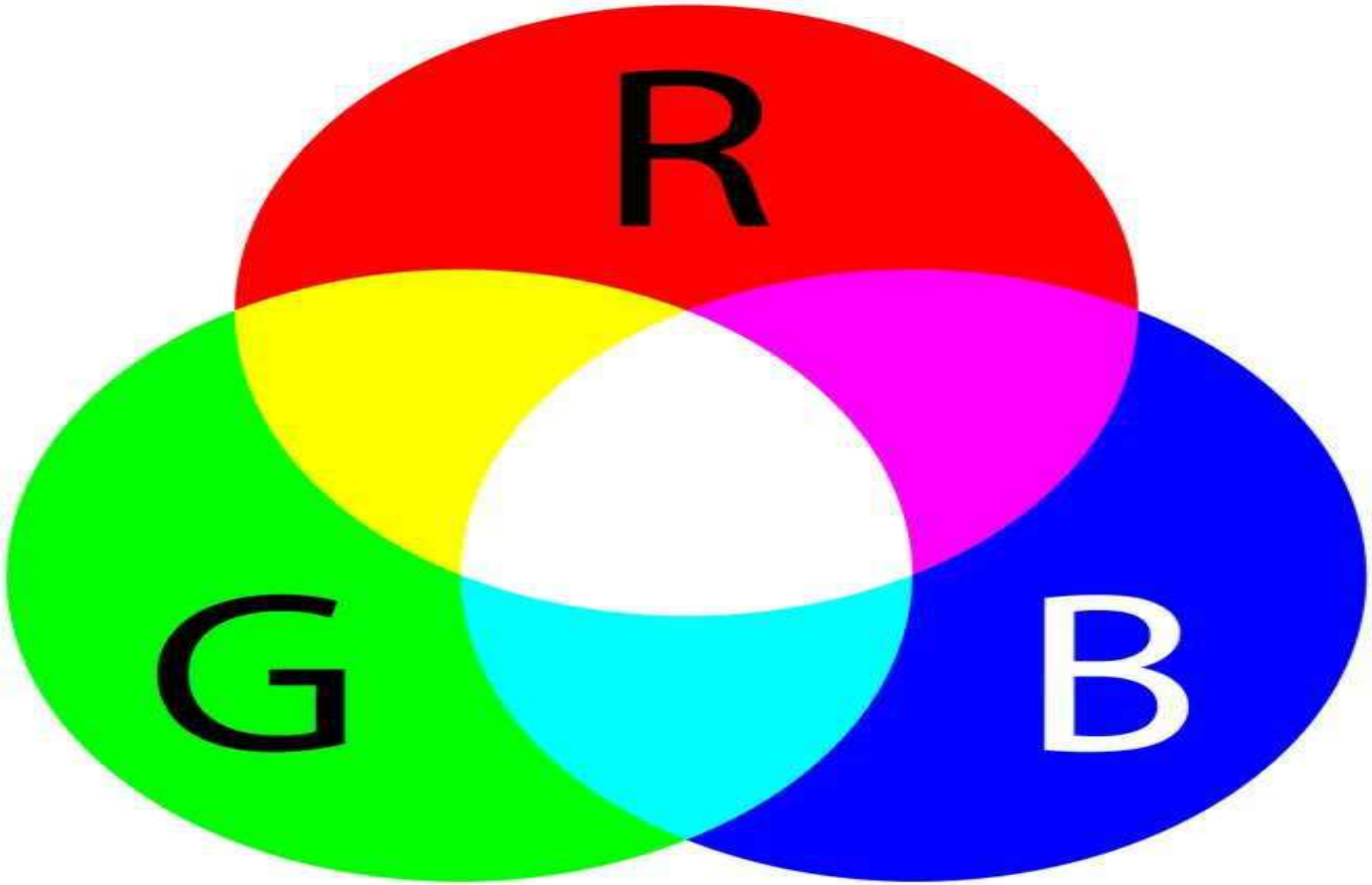
RGB:
The RGB colour model relates very closely to the way we perceive colour with the r, g and b receptors in our retinas. RGB uses additive colour mixing and is the basic colour model used in television or any other medium that projects colour with light. It is the basic colour model used in computers and for web graphics, but it cannot be used for print production. The secondary colours of RGB – cyan, magenta, and yellow – are formed by mixing two of the primary colours (red, green or blue) and excluding the third colour. Red and green combine to make yellow, green and blue to make cyan, and blue and red form magenta. The combination of red, green, and blue in full intensity makes white.



The RGB Cube

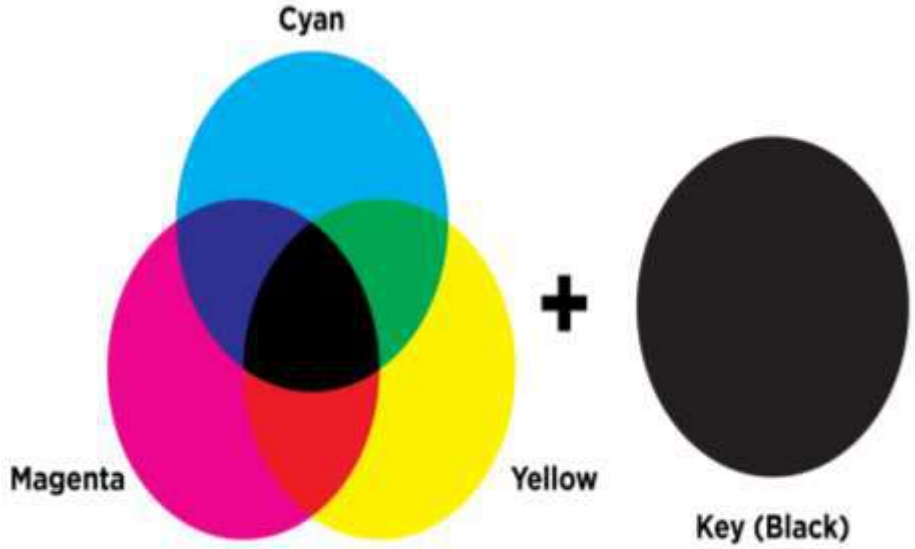


The CMY Cube


R
G
B

CMYK

The 4-colour CMYK model used in printing lays down overlapping layers of varying percentages of transparent cyan (C), magenta (M) and yellow (Y) inks. In addition a layer of black (K) ink can be added. The CMYK model uses the subtractive colour model.



CMYK Colors

FILE FORMAT

- The **file format** is the structure of a file that tells a program how to display its contents. For example, a Microsoft Word document saved in the .DOC file format is best viewed in Microsoft Word. Even if another program can open the file, it may not have all the features needed to display the document correctly.
- Programs compatible with a file format can give an overview of a file but may not be able to display all the file features. Also, with some programs opening a file format that is not supported may give you garbage.


DOC
W
TXT
T
XLS
MP3
CSV
DLL
VOB
RAR
JPG
PNG
EXE
HTML

COMMON FILE FORMATS

- Below is a listing of common file formats you are most likely to encounter while working on a computer. Click any of the links below for more information about the type of file or the extension.

File type	File extension
Text	.asc .doc .docx .rtf .msg, .pdf .txt .wpd .wps
Image	.bmp .eps .gif .jpg .pict .png .psd .tif
Sound	.aac .au .mid .mp3 .ra .snd .wma .wav
Video	.avi .mp4 .mpg .mov .wmv
Program	.bat .com .exe
Compressed	.arc .arj .gz .hqx .rar .sit .tar .z .zip

PDF

- Short for **Portable Document Format**, **PDF** is a file format and file extension developed by Adobe that enables users to capture the native appearance of a document. It is useful because it allows the document to be viewed and printed the same way on any device. PDF files are frequently used in legal documents, such as tax papers, bank statements, and other forms that need the user to fill in data. Clicking the Adobe PDF file icon to the right opens an example of a PDF file if **Adobe Acrobat Reader** or other PDF reader is installed on your computer.



JPEG

- Short for **Joint Photographic Experts Group**, **JPEG** is a digital image compression format, and one of the most popular image types shown on the Internet and used with digital cameras. The JPEG standard uses a lossy sacrificed to achieve greater compression. JPEG is also abbreviated as **JPG** in the file extension used with IBM compatible computers. The image is an example of a JPEG image.



GIF



- Pronounced *jiff* and short for **Graphics Interchange Format**, **GIF** is a file extension and a bitmap graphics file introduced by CompuServe (primarily Steve Wilhite) in 1987.
- Today, it is one of the most commonly used images on the Internet. The original release of the GIF standard was known as the GIF87a version. The GIF87a standard was later replaced in 1989 when CompuServe released an improved version known as GIF89a. This improved version supported animation and transparent images.
- On December 24, 1994, Unisys and CompuServe announced that they expected licensing fees for software that creates and displays GIF images. The thought of fees caused hysteria among developers and website owners using GIF images. Because of potential future GIF taxes, this hysteria led to the development of the PNG format. The Software Freedom Law Center announced after October 1, 2006, all patent claims interfering with the employment of the GIF format expire and users should have no concerns using the format.

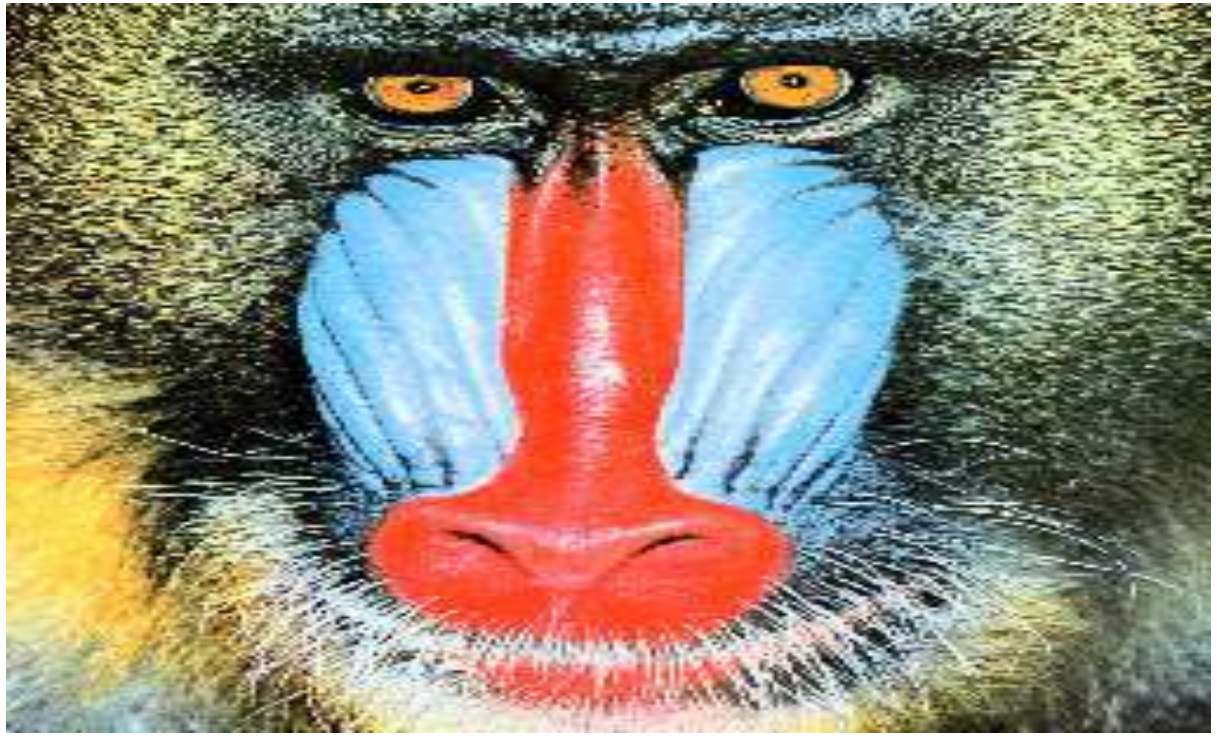
PNG

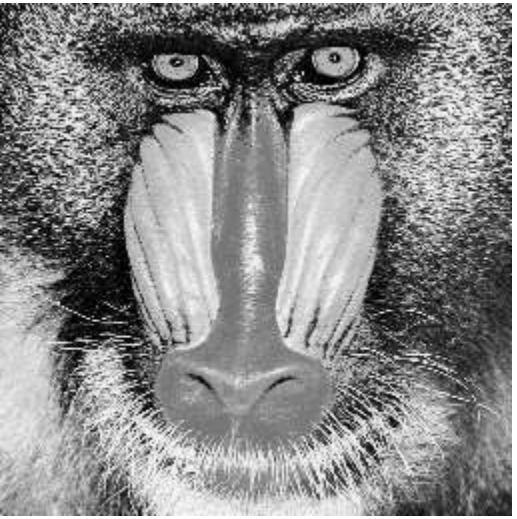
- Short for **Portable Network Graphics**, **PNG** is pronounced as either the letters *P-N-G* or the word *ping.* It is a bitmapped image format featuring lossless compression.
- One of the best aspects of the PNG format is that it facilitates transparent images, which is helpful in many instances. For example, a website creator may want to have a logo on their page that doesn't hide the background. Transparency is also useful when adding pictures to a web page that need to work in light mode and dark mode.



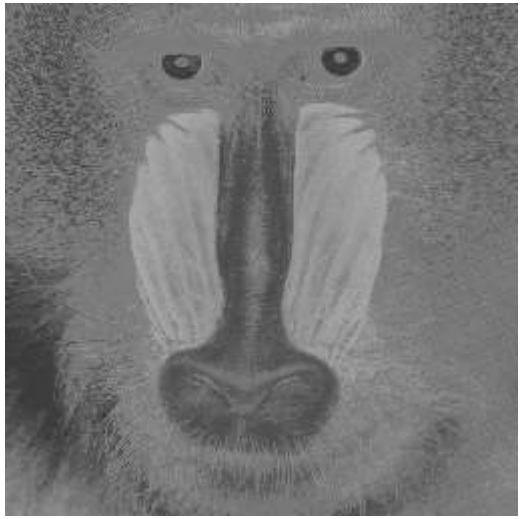
COLOR MODELS IN VIDEO

- YIQ and YUV are the two commonly used color models in video
- **YUV Color Model**
- Initially, for PAL analog video, it is now also used in CCIR 601 standard for digital video
- Y (luminance) is the CIE Y primary.$Y = 0.299R + 0.587G + 0.114B$
- *Chrominance* is defined as the difference between a color and a reference white at the same luminance. It can be represented by U and V -- the *color differences*.$U = B - Y$
  $V = R - Y$
  - If b/w image, then U = V = 0. --> No chrominance!
  - ** In actual PAL implementation:$U = 0.492\ (B - Y)$
    $V = 0.877\ (R - Y)$
- Sample YUV Decomposition:

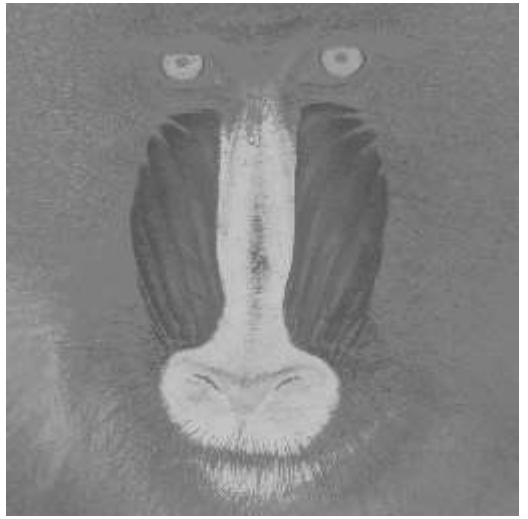




Y



U



V

YCBCR COLOR MODE

- **YCbCr Color Model**

- The YCbCr model is closely related to the YUV, it is a scaled and shifted YUV.Cb = (B - Y) / 1.772 + 0.5
  Cr = (R - Y) / 1.402 + 0.5
- The chrominance values in YCbCr are always in the range of 0 to 1.
- YCbCr is used in JPEG and MPEG

YIQ COLOR MODEL

•YIQ is used in NTSC color TV broadcasting, it is downward compatible with B/W TV where only Y is used.
•Although U and V nicely define the color differences, they do not align with the desired human perceptual color sensitivities. In NTSC, I and Q are used instead.
I is the orange-blue axis, Q is the purple-green axis.
I and Q axes are scaled and rotated R - Y and B - Y (by 33 degrees clockwise).
I = 0.877(R - Y) cos 33 - 0.492(B - Y) sin 33
Q = 0.877(R - Y) sin 33 + 0.492(B - Y) cos 33
Namely,
I = 0.736(R - Y) - 0.268(B - Y) = 0.596R - 0.275G - 0.321B
Q = 0.478(R - Y) + 0.413(B - Y) = 0.212R - 0.523G + 0.311B
•The YIQ transform:

$$\begin{bmatrix} Y \\ I \\ Q \end{bmatrix} = \begin{bmatrix} 0.299 & 0.587 & 0.114 \\ 0.596 & -0.275 & -0.321 \\ 0.212 & -0.523 & 0.311 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

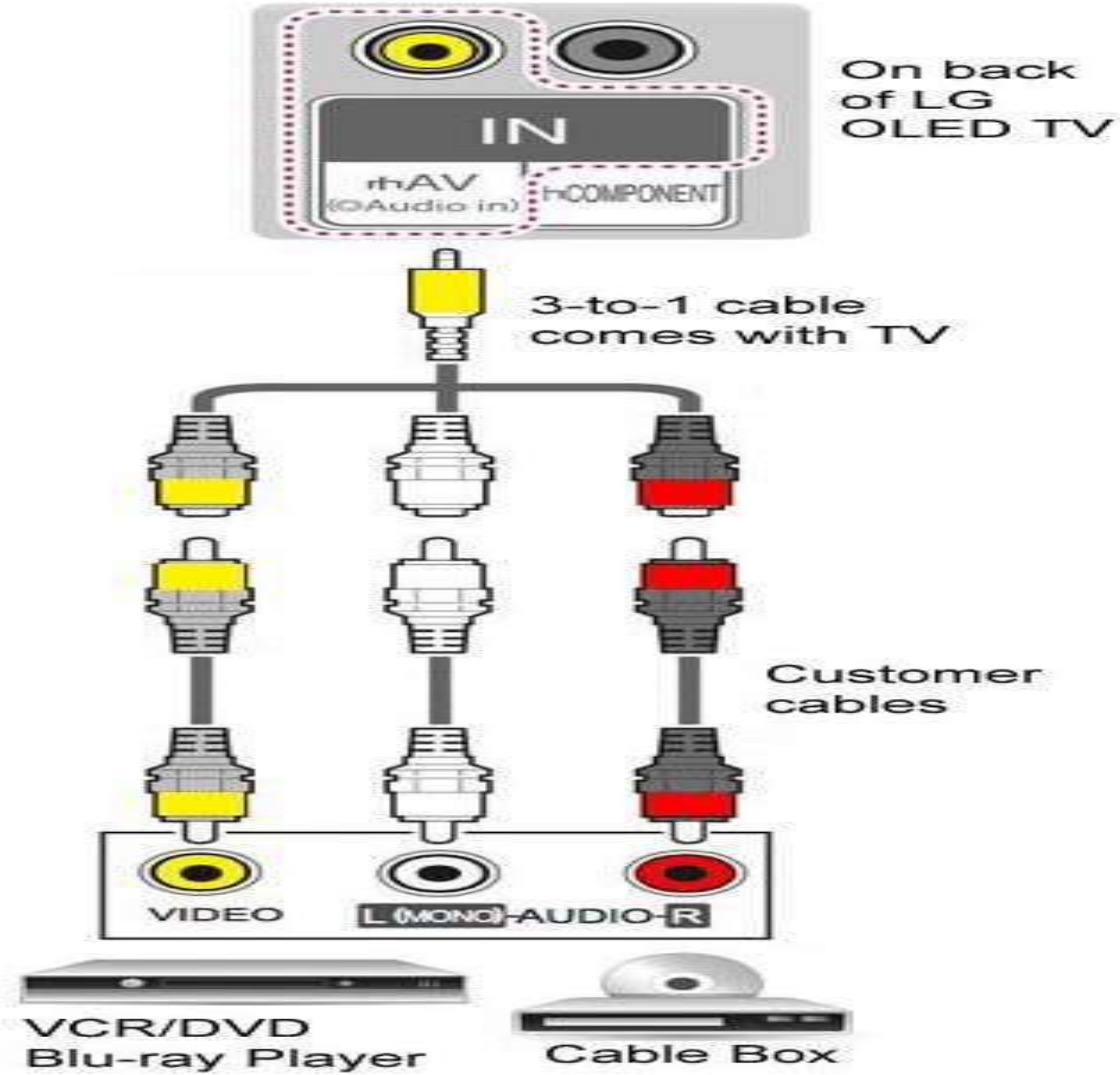
•Eye is most sensitive to Y, next to I, next to Q.
In NTSC broadcast TV, 4.2 MHz is allocated to Y, 1.5 MHz to I and 0.55 MHz to Q. For VCR, Y is cut down to 3.2 MHz and I to 0.63 MHz.

What are the different types of video signals?

- There are three types of video signals as follows:
- Composite Video
- Component Video
- S-Video

Composite Video

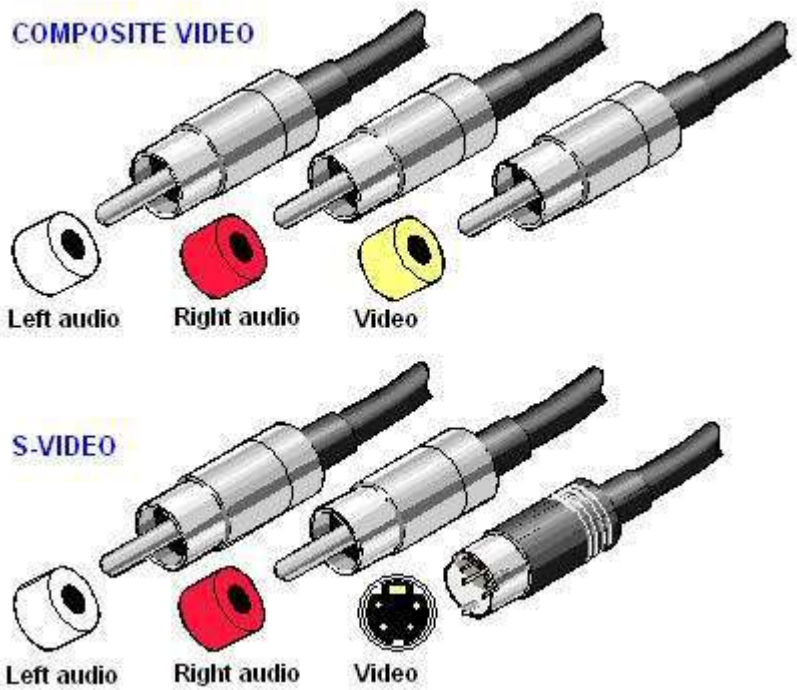
- The first analog video color format, which uses one channel and a single cable (the audio tracks transmit in separate channels and cables). All old analog TVs and many digital TVs have composite video inputs (LG example below)


IN
rhAV
(OAudio in)
hCOMPONENT
On back of LG OLED TV
3-to-1 cable comes with TV
Customer cables
VIDEO
L (MONO) AUDIO R
VCR/DVD Blu-ray Player
Cable Box

- The original TV standard combined (Y) and both color signals (U) and (V) into one channel, which uses one cable and is known as "composite video."
- Composite video was created when color was added to black & white TV in 1954. Two color signals (U and V) were multiplexed with the original monochrome signal (Y) and transmitted in the same TV channel.
- Composite Video Is Yellow
- The yellow RCA jack is the composite video socket found on video devices.
- In composite video, three source signals are combined with sync pulses to form a composite video signal. The three source signals are referred as YUV in which Y represents the brightness of the picture and it also includes the synchronizing pulses.
- The color information is carried between U and V. However, two orthogonal phases of a color carrier signal are mixed with them in the first place to form a signal called as chrominance. The Y signal and the UV signal are then combined together.
- The signals are compressed and then channeled through a single wire.
- The chrominance and luminance components can be separated at the receiver end and then the two color components can be further recovered.
- When connecting to TVs or VCRs, Composite Video uses only one wire and video color signals are mixed, not sent separately.
- The audio and sync signals are additions to this one signal. Since color and intensity are wrapped into the same signal Some interference between the luminance and chrominance signals is inevitable (unavoidable)

S-VIDEO

- S-video was one of a number of enhancements in bringing the signal from the video cassette player to TVs, and separated video signal (luminance) and color signal (chrominance).
- S-video is a technology for transmitting video signals over a cable by dividing the video information into two separate signals: one for color (chrominance), and the other for brightness (luminance).
- When sent to a television, this produces sharper images than Composite Video, where the video information is transmitted as a single signal over one wire. This is because televisions are designed to display separate Luminance (Y) and Chrominance (C) signals.
- Computer monitors are designed for RGB (short for Red, Green, Blue monitor) signals. Most digital video devices such as digital cameras and game players produce video in RGB format. The images are clearer when displayed on a computer monitor. When displayed on a standard television, however, they look better in S-Video format than in Composite Video format.
- To use S-Video, the device sending the signals must support S-Video output and the device receiving the signals must have an S-Video input jack. Then you need an S-Video cable to connect the two devices.
- S-Video cable doesn't always come standard with a TV, and usually must be purchased separately.
- S-Video cables carry four or more wires wrapped together in an insulated sleeve, with S-Video connectors at either end. It is only for video and requires separate audio cables, but it provides a slightly better picture than a composite video cable.
- Like composite video, S-video connectors are widely used on VCRs, DVD players and receivers. The audio for both composite video and S-video uses common left/right stereo connections.


COMPOSITE VIDEO
Left audio
Right audio
Video
S-VIDEO
Left audio
Right audio
Video



COMPONENT VIDEO

- Component video is a video signal that has been split into two or more components. In popular use, it refers to a type of analog video information that is transmitted or stored as three separate signals.
- Component analog video signals do not use R, G, and B components but rather a colorless component, termed luma, which provides brightness information (as in black-and-white video).
- This combines with one or more color-carrying components, termed chroma, that give only color information.
- In component video, the luminance (Y) and two color difference signals (U and V or I and Q) are separated into three separate analog signals that can be transmitted over three separate wires.
- Component video is used in professional video production and provides the best quality and the most accurate reproduction of colors.
- Component Video gives the best color reproduction since there is no crosstalk between the three channels. Component video requires more bandwidth and good synchronization of the three components.
- Component video cables come in three-wire sets shown below.

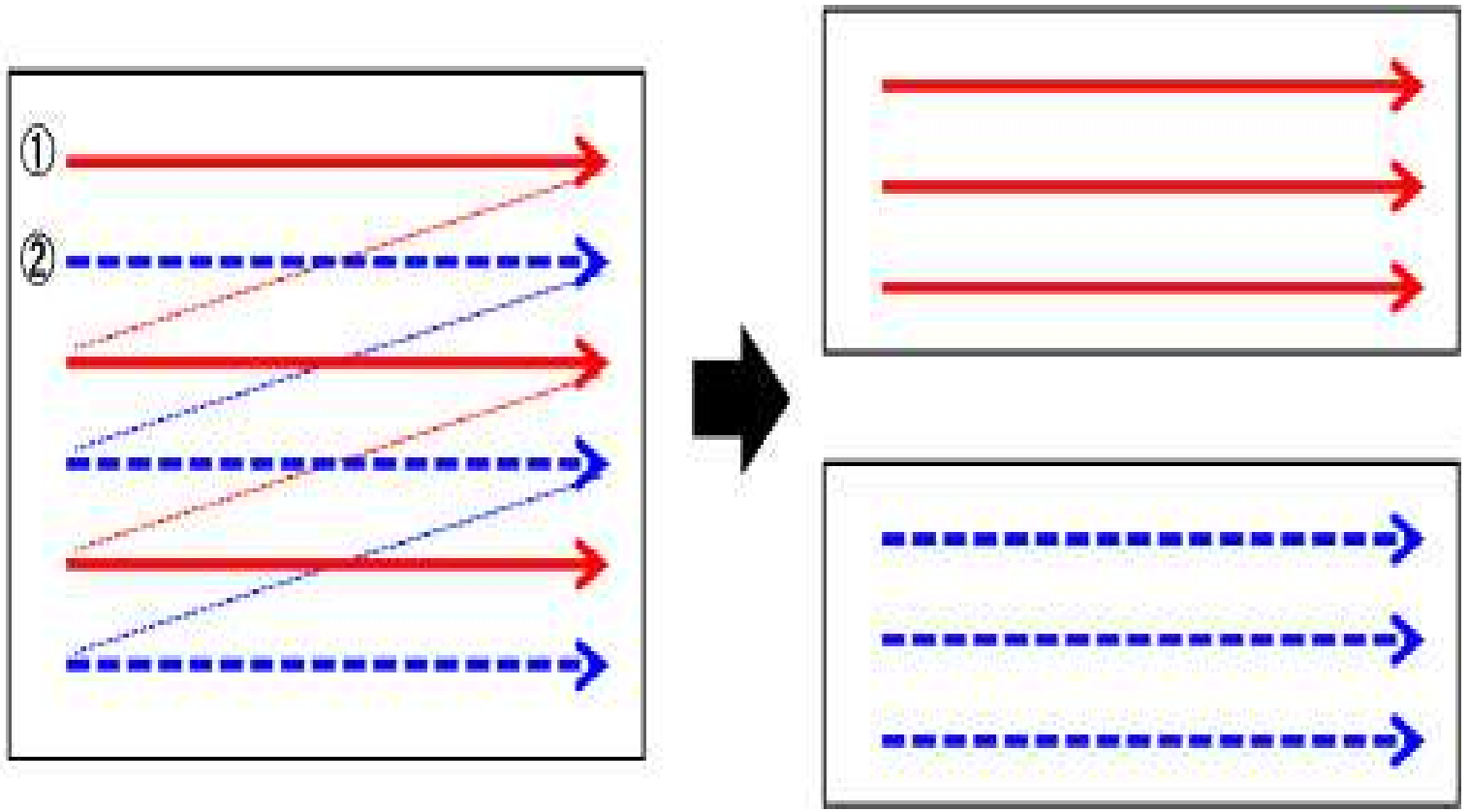


Analog Video

- Analog video is represented as a continuous (time varying) signal; Digital video is represented as a sequence of digital images NTSC Video 525 scan lines per frame, 30 fps (33.37 msec/frame). Interlaced, each frame is divided into 2 fields, 262.5 lines/field 20 lines reserved for control information at the beginning of each field So a maximum of 485 lines of visible data • Laserdisc and S-VHS have actual resolution of ~420 lines • Ordinary TV -- ~320 lines • Each line takes 63.5 microseconds to scan. Color representation: • Uses YIQ color model. PAL (SECAM) Video 625 scan lines per frame, 25 frames per second (40 msec/frame) Interlaced, each frame is divided into 2 fields, 312.5 lines/field Color representation:

FRAME RATE AND INTERLACING

- Persistence of vision: The human eye retains an image for a fraction of a second after it views the image. This property is essential to all visual display technologies. The basic idea is quite simple, single still frames are presented at a high enough rate so that persistence of vision integrates these still frames into motion. Motion pictures originally set the frame rate at 16 frames per second. This was rapidly found to be unacceptable and the frame rate was increased to 24 frames per second. In Europe, this was changed to 25 frames per second, as the European power line frequency is 50 Hz. When NTSC television standards were introduced, the frame rate was set at 30 Hz (1/2 the 60 Hz line frequency). Movies filmed at 24 frames per second are simply converted to 30 frames per second on television broadcasting.


①
②

THANK YOU

