"Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them."

Co-funded by the European Union

Studio Production and Directing

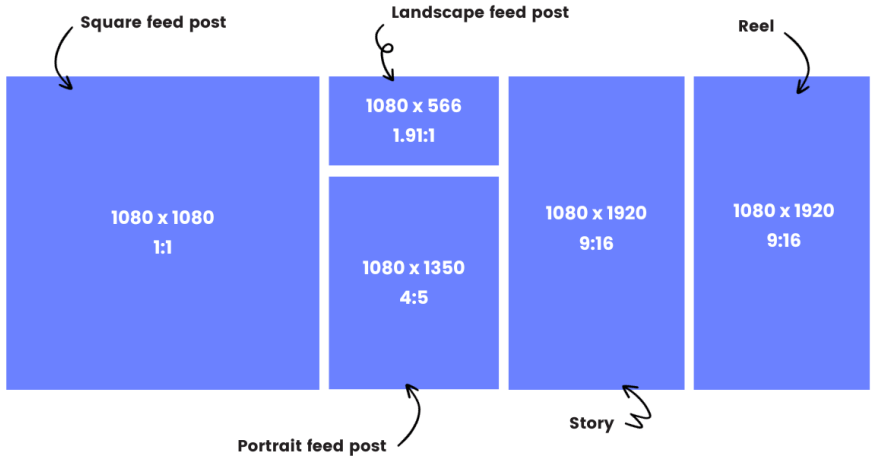
Aspect Ratios

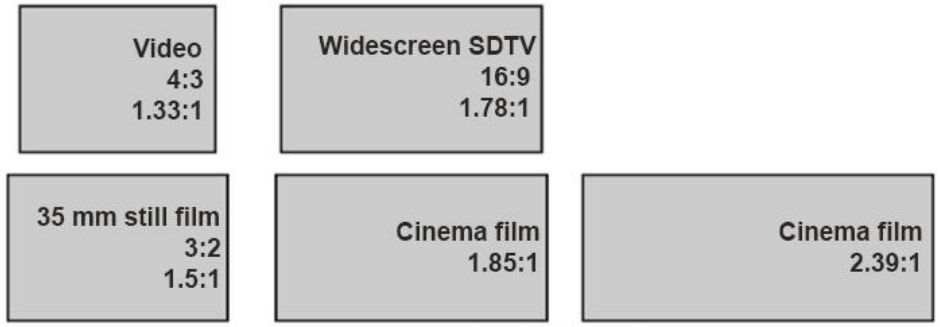
Vladimir Maksimovic

University of Mitrovica (UPKM)

Aspect ratio

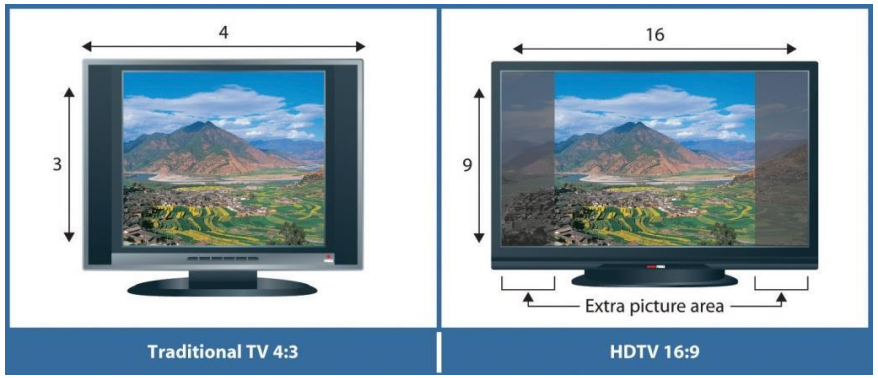
- The aspect ratio represents the proportion of the image dimensions, i.e. what is the ratio of the width and height of the image.
- The cinema film uses a 1.85:1 image format which is called a "flat" or "spherical" format.
- Most HDTV screens have a 16:9 aspect ratio, similar to that of cinema screens, so the image displayed in this format resembles a cinematic one.





Aspect ratio

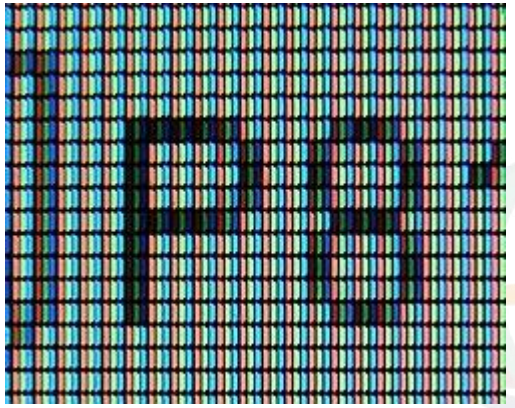
- A film image can be transformed to 4:3 dimensions by cropping part of the image from the sides. Another method of this transformation is called pan-and-scan, which, instead of a fixed side crop, shifts the frame left or right depending on the scene of the film.
- Instead of cropping parts of the image, the so-called letterbox format is more commonly used, which allows the entire image to be retained. In this method, no parts of the image are lost, the full width of the screen is used, with black or gray bars added to the top and bottom of the image, which are not used for display.



Aspect ratio

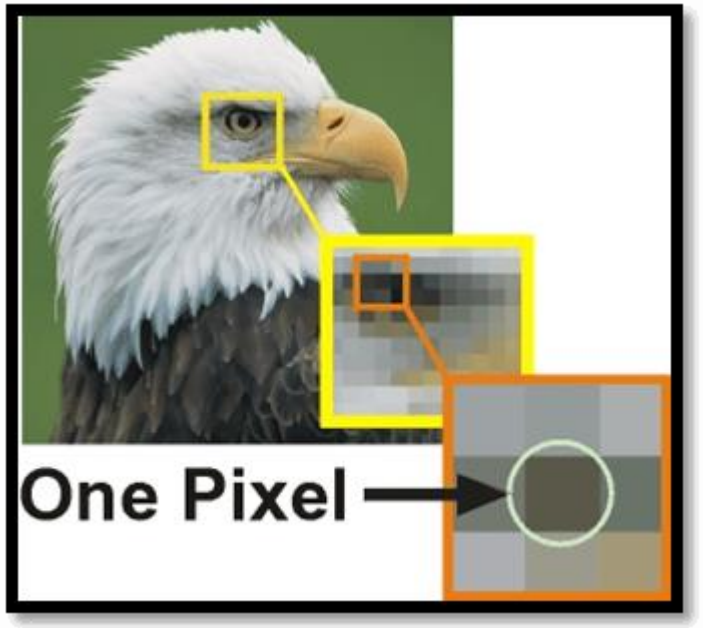
- Pixel is the smallest part of an image.
- They represents the basic building block of every screen.
- A pixel is essentially a cell whose color and brightness level can be changed.
- The resolution represents the number of pixels that compose a single screen. The higher this number, the higher the quality and sharpness of the displayed image.

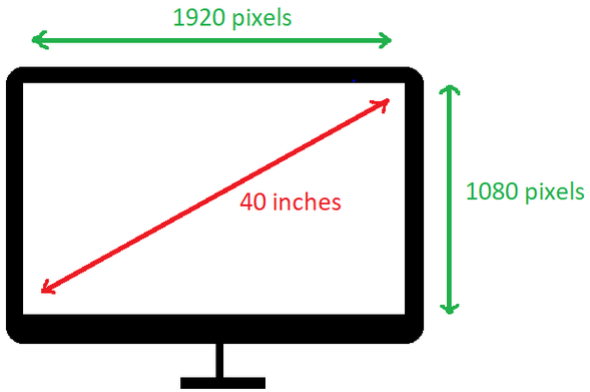
- Device resolution – the physical screen (printer, laptop, phone)
- Image resolution – the digital image resolution (JPGE, PNG …)

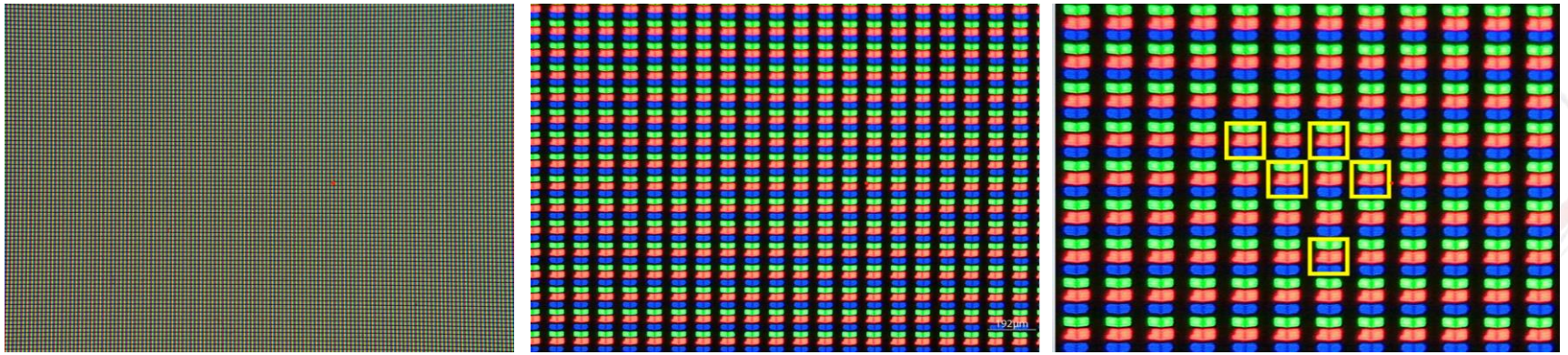


Aspect ratio

- Images are composed of a set of pixels along the X and Y axes, for example 24×24, which represents the resolution of a digital image.
- How to determine the resolution of a physical device? How many pixels are on the screen?
- The yellow square represents a pixel: each pixel has 3 sub-pixels.
- By adding horizontal and vertical pixels, we obtain the physical resolution of the screen.







Co-funded by
the European Union

Aspect ratio

- TVs:
  - DVD, HD, FULLHD, 4K, 8K, etc.
- Digital cametas:
  - Magapixels (8mp, 21.5mp, 50mp, etc.)
- Printers:
  - DPI (1440dpi, 2400dpi, etc.)
- Phones, tablets, etc:
  - PPI (72ppi, 144ppi, 450ppi, 480ppi, etc.)

Image format: Televisions

- If the number of pixels is counted vertically, 480 pixels are obtained in one line (480i is DVD resolution: 640x480)
- This was the standard for analogue television using CRT technology. Standard television can display 576 or 480 lines of pixels, respectively.
- It takes 1/50 or 1/60 of a second to draw each line. The lines are drawn by first rendering the odd lines, followed by the even lines, which is commonly called interlaced scanning.

- SDTV is a type of digital television that can transmit and produce images of higher quality than those obtained through standard analogue broadcasting. SDTV usually has a resolution of 720×576i, or 720×480i. Although SDTV cannot match HDTV in quality, it is superior compared to conventional (analogue) television.
- The numbers represent vertical resolution, while the letters indicate interlaced (i*) or* progressive (*p) scanning. For example, 480 represents a vertical resolution of 480 lines with* interlaced scanning.

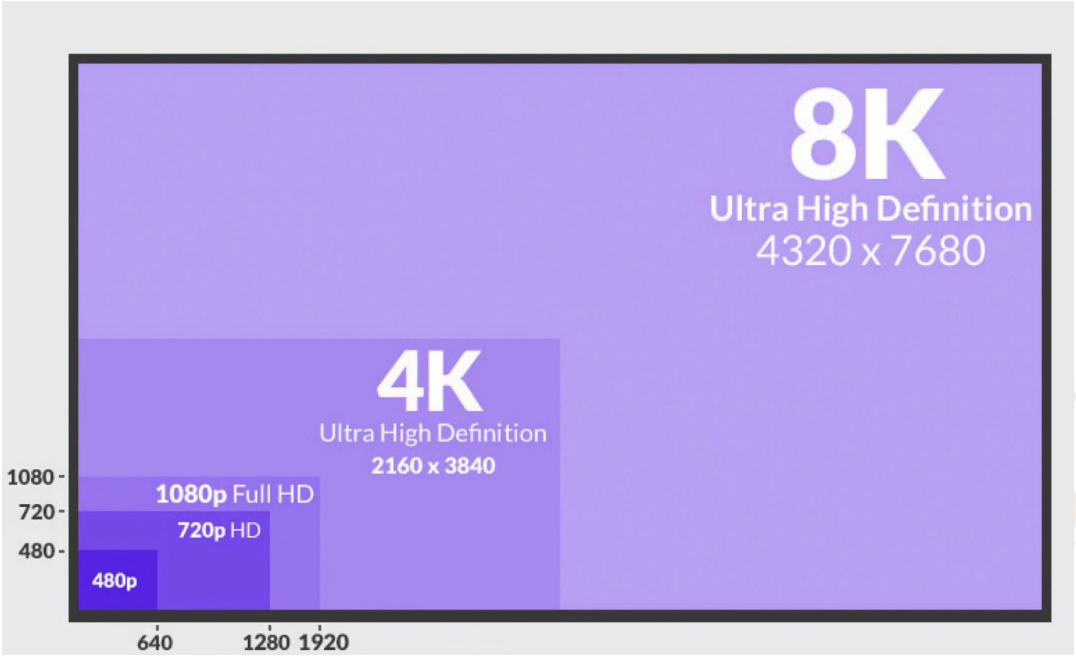


Image format: Televisions

- High Definition Television (HDTV) is probably the most important innovation in television since the introduction of color. Commercial HDTV services have become a reality, and HD broadcasting is now common.
- HDTV can transmit six times more information than the old analog systems, thereby creating a better image and sound quality.
- High-resolution television comes in two versions: 1280×720 pixels or 1920×1080 pixels. On TV receivers, the screen resolution is always clearly indicated.

- Some of the common labels are: HD 720i, HD 720p, HD 1080i, HD 1080p.
- All commercial HDTV is digital, so the image quality of such a signal is nearly perfect. Snow, interference, and other unwanted effects common in analog television do not exist.
- The image contains two to five times more detail. The gaps between the scan lines are less visible or almost invisible.
- Increased image sharpness and higher number of details provide a better viewing experience.

	rezolucija	odnos strana	slika u sekundi (i - ispreplетano, p - progresivno)	
			SAD	Evropa
HDTV	1920×1080	16:9	24p, 30i/p	24p, 25i/p, 30i/p
	1280×720	16:9	24p, 30p, 60p	24p, 25p, 30p, 50p, 60p
SDTV	720×576	4:3 / 16:9	/	24p, 25i/p, 30p, 50p
	704×480	4:3 / 16:9	24p, 30i/p, 60p	/
	640×480	4:3	24p, 30i/p, 60p	/

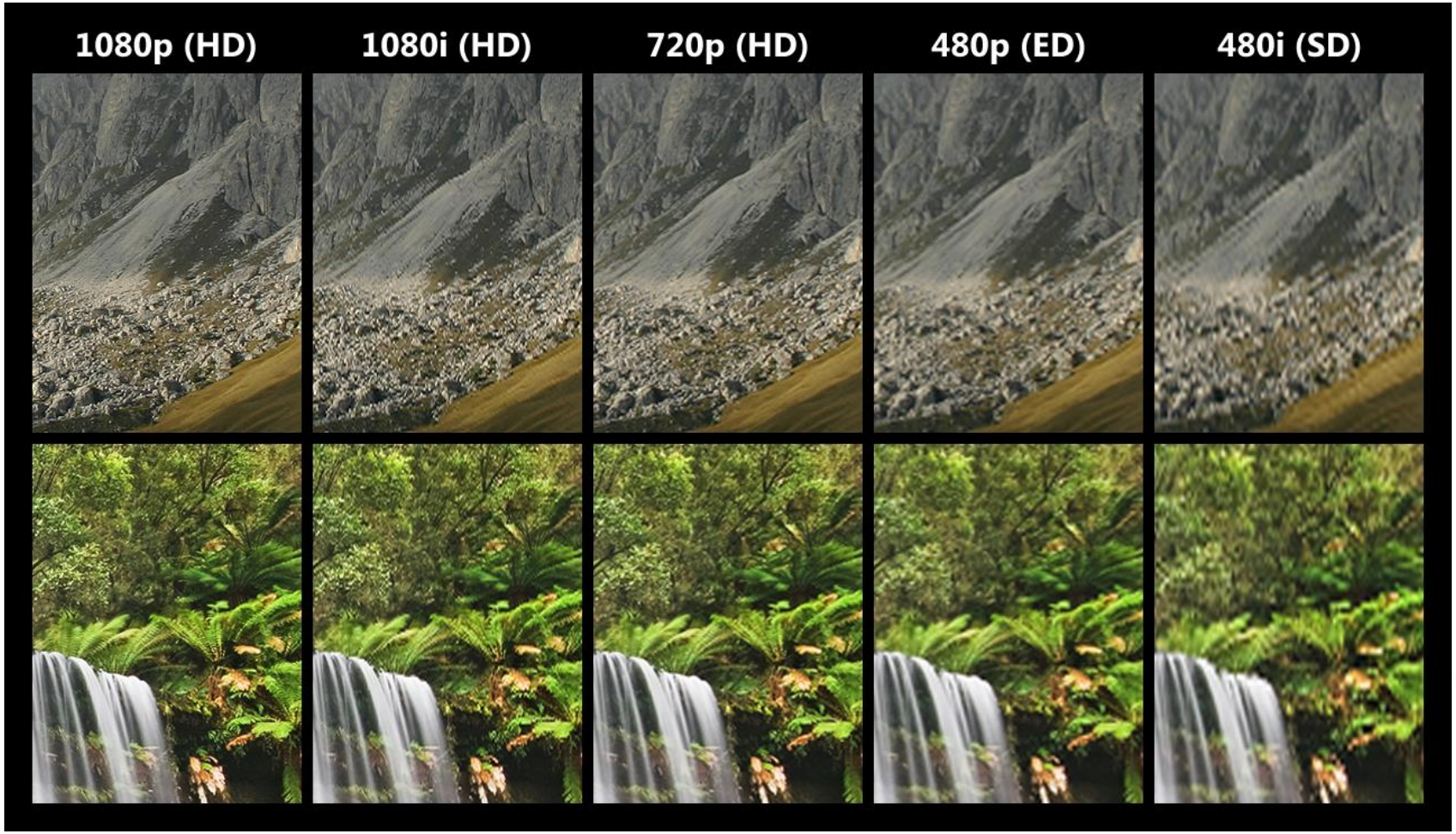
Image format: Televisions

- Ultra High-Definition Television (UHDTV) includes 4K UHDTV (2160p) and 8K UHDTV (4320p), which are two digital video formats proposed by NHK Science & Technology Research Laboratories and approved by the International Telecommunication Union (ITU)
- Given that there are two UHD (or QHD) resolutions, 3840×2160 and 7680×4320, for easier identification, the first is often called UHD-1 (4K) and the second UHD-2 (8K).
- The advantages of UHD include better image display (higher amount of information) – producing more realistic picture especially on 55"+ screens, and better color representation.
- For a realistic display, in addition to resolution, important factors include color dynamic range, color depth, and frame rate.
- UHD is less meaningful on smaller screen sizes.
- Disadvantages of UHD: price, high bitrate, and production complexity.

	HDTV	4K UHDTV	8K UHDTV
Broj piksela x broj linija	1280×720 p 1440×1080 i 1920×1080 p(i)	3840×2160	7680×4320
Mega piksela / Frejm	0.922 1.6 2.1	8.3 progresivno	33.2 progresivno
Format slike	16:9	16:9	16:9
Broj frejmova	25, 50, … fps 30 fps +24 fps	25, 50, … fps 30, 60, 120 fps +24 fps	25, 50, … fps 30, 60, 120 fps +24 fps
Bit Depth	8 ili 10 bita	10 ili 12 bita	10 ili 12 bita

Co-funded by
the European Union

Image format: Televisions



Co-funded by
the European Union

Image format: Televisions

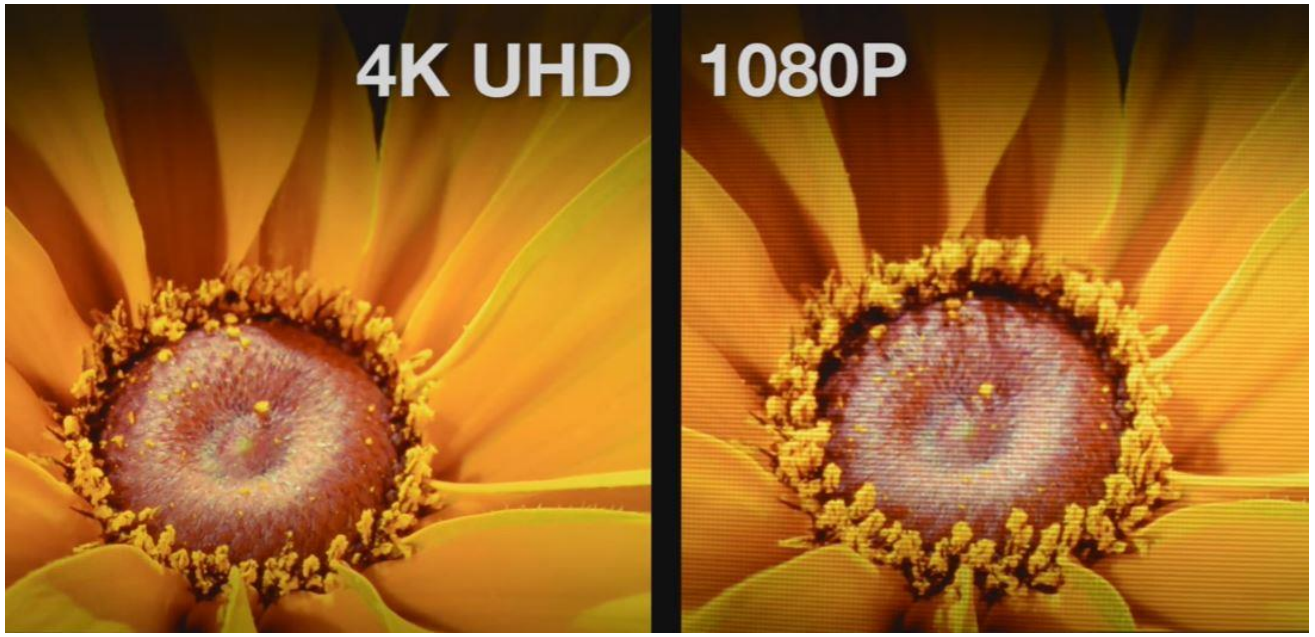
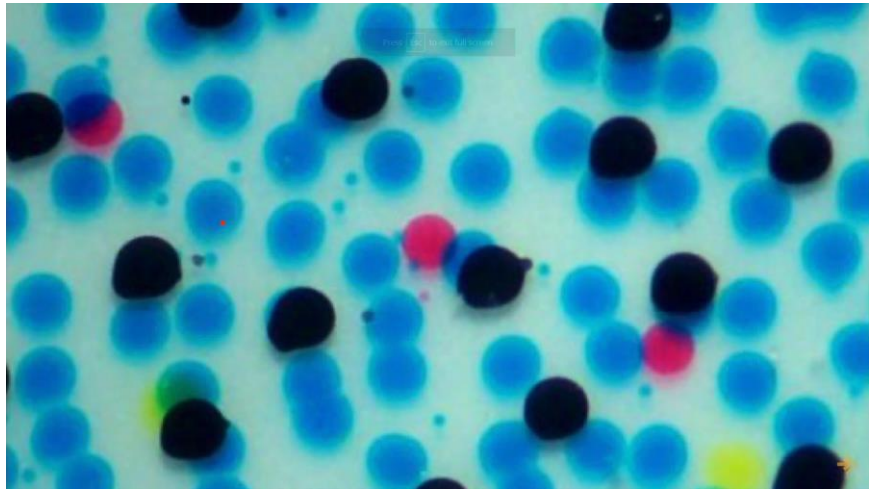


Image format: Digital cameras

- Camera resolution refers to the resolution of the sensor.
- How many physical pixels can this camera "capture"?
- So how do you calculate a megapixels?
- Pixel width x pixel height/1000000 equals the number of megapixels, which indicates how much the camera sensor can "capture".

Image format: Printers

- Printers do not have square pixels, instead, they use a cross-shaped arrangement.
- Printers apply ink or toner onto paper to print.
- Inkjet printers have nozzles that spray tiny ink droplets, while laser printers fuse toner onto paper. The more dots you can fit into a square inch, the sharper the resulting image. A 600dpi printer places 600 dots horizontally and 600 dots vertically in each square inch of the sheet.
- Dpi represents the dot density per inch (1 inch = 2.54 cm) and provides information about how detailed a display or print is, using the CYMK color system.
- Printers can achive much higher resolution than physical devices, because they can use many smaller dots.
- Most printed material is produced at a resolution of 300 DPI (300 dots per inch) because the human eye can perceive detail at about 300 DPI from a viewing distance of 30 cm.



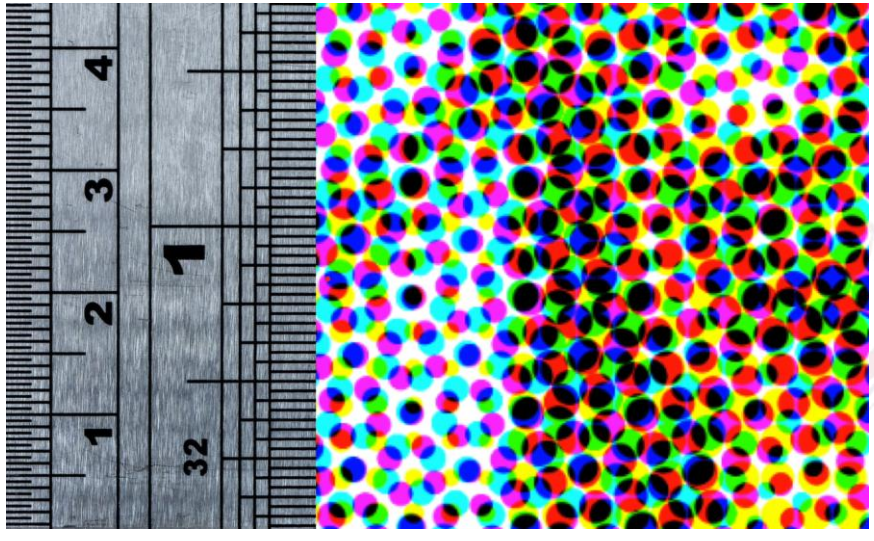
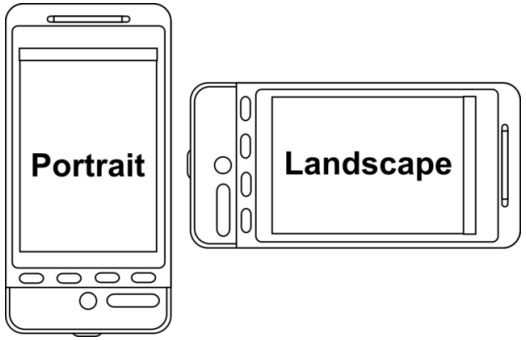
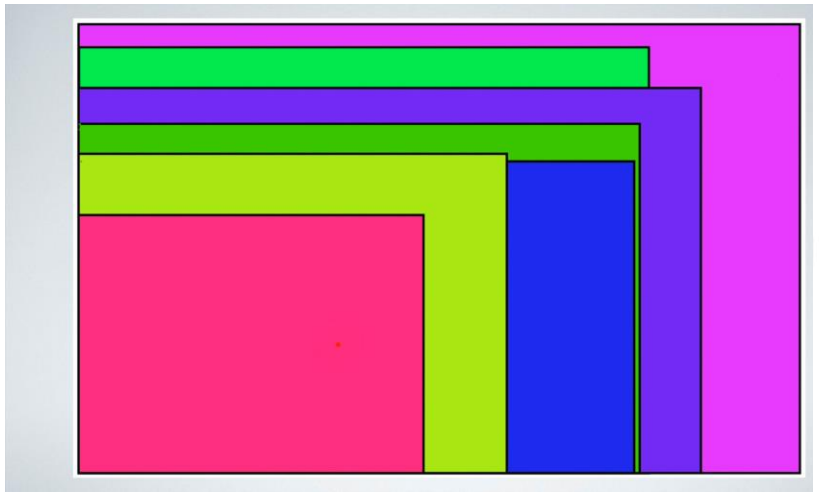


Image format: Phones, tablets …

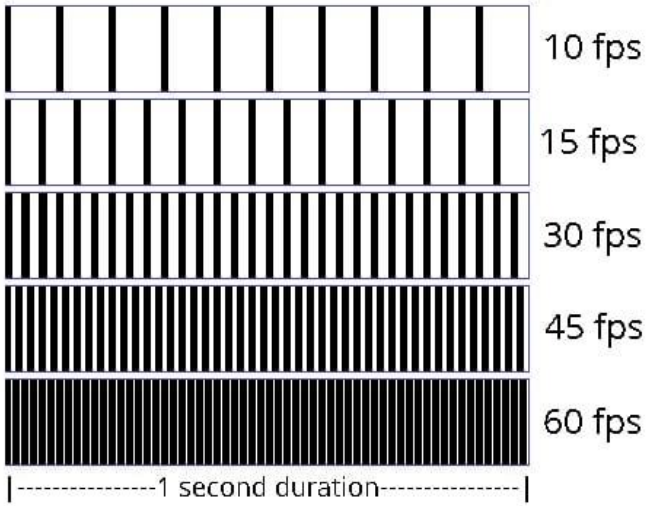
- The problem with phones is that they don't have a standardized page ratio and orientation
- PPI (Pixels per inch) – pixel per inch
- 72 ppi – "Screen Resolution": Standard fot digital Image
- 300 ppi – "Print Resolution": Standard for printing
- Today, phones generally range from 200 to 500 PPI.
- Laptops and PCs generally range from 100 to 200 PPI.
- Example in Photoshop using the Resample function



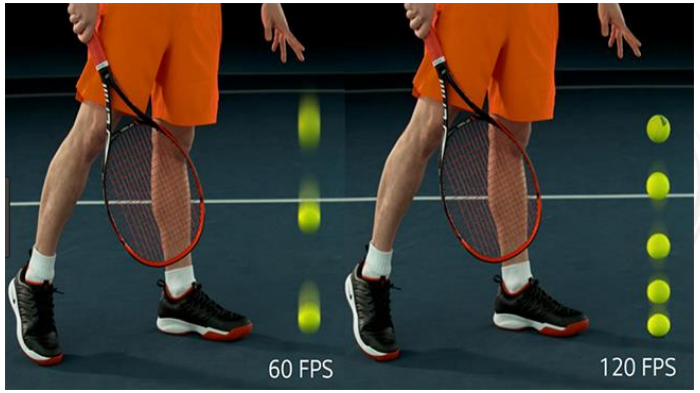


Video format

- What is framerate? What framarte is used as standard?
- For each frame, settings similar to photography are used: ISO, F, etc.
- What is color depth?



- Is more than 8bit of color depth necessary?
- Resolution x Color depth x framerate = Raw data / sec
- What is bitrate and how much bitrate is needed?



3D TV

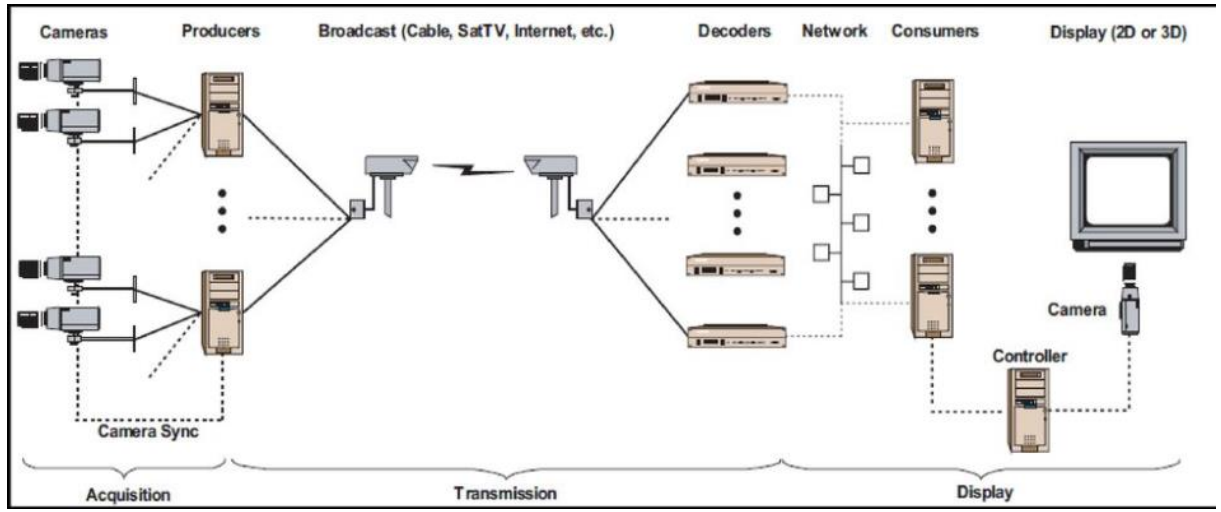
- 3D television allows viewers to see image with depth and three-dimensional effect (with or without glasses).
- 2010 will be remembered for the mass promotion of 3D products and services worldwide
- There are many advantages and disadvantages.

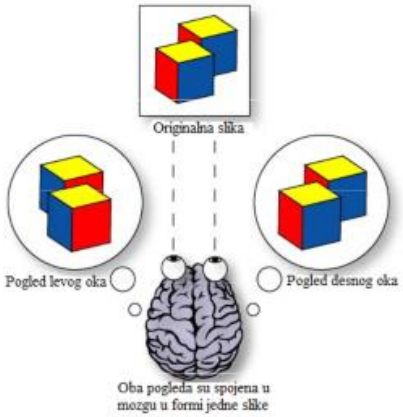
- What is needed to watch 3D TV:

1. A 3D TV receiver
2. 3D glasses compatible with the display technology used by 3D TV
3. A 3D Blu-ray player, a 3D TV with built-in 3D technology, or a PC equipped with a graphics card that supports stereoscopic 3D
4. 3D content, whether it is a 3D Blu-ray movie, a 3D satellite program, or a 3D compatible game.

3D TV: Principle of operation

- **Working rinciple:** 3D content is displayed using two images – one for the left and the other for the right eye.
- **3D cameras:** They use two lenses, simulating the distance between human eyes.
- **Display technology:**
  - Fast screen refresh allows accurate image representation.
  - Each eye receives enough information to perceive depth.
  - Certain image elements can be visually appear to come out of the screen.
  - 3D TVs provide a greater sense of depth compared to traditional 2D models.





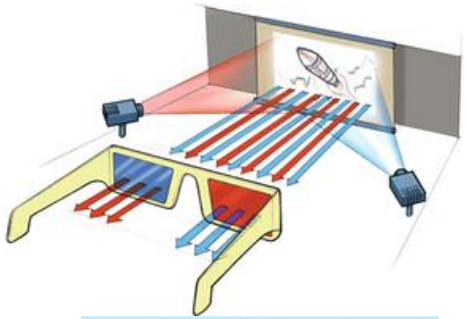
Co-funded by
the European Union

3D TV: Principle of operation

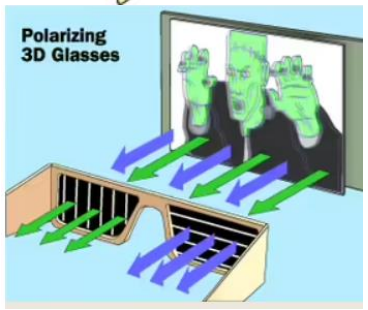
- **Types of 3D display:**
  - Stereoscopic display – requires wearing special glasses.
  - Autostereoscopic display – allows viewing 3D content without glasses.
- **3D display technologies:**
  - Active 3D – uses darkened (shutter) glasses that synchronously allow the image to each eye.
  - Passive 3D – uses polarized glasses and transmits two images with different polarization orientations.

3D TV: Principle of operation

- Anaglyph glasses:
  - They use **red and blue** to filter the image for each eye.
  - Each eye sees only a part of the image, and the brain combines them into a 3D effect.
  - **Advantage**: inexpensive and do not require a separate screen.
  - **Disadvantage**: Poor colour reproduction and visual distortion.



- Polarized glasses
  - The screen emits **two images with different polarization orientations** (vertical and horizontal).
  - The glasses filter the light so that each eye sees the corresponding image.
  - **Advantage**: Better color rendering and greater comfort.
  - **Disadvantage**: Requires special screens with polarization filters.



- Active shutter glasses:
  - Synchronized with the screen which alternately displays images for the left and right eye.
  - Glasses use **LCD lenses that darken quickly and let the mage through**.
  - **Advantage**: High image quality and full resolution.
  - **Disadvantage**: Expensive system, can cause eye strain.

WBnet

Co-funded by the European Union

Questions & Answers

"Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them."

Network of centers for regional short study programs in the countries of the Western Balkans

Call: ERASMUS-EDU-2023-CBHE

Project number: 101128813

ATYCC

UNIVERSITY OF L]UBL]ANA
Faculty of Electrical Engineering

POLITÉCNICA

University of Pristina
Kosovska Mitrovica