



Video

Video

- Videre (lat.) - to see
- Electronic medium for the recording, copying, playback, broadcasting, and display of moving visual (and audio) media
- Digital video – digital representation of video
 - Sequence of digital images
 - Compression algorithms
 - (+ digital sound)

Temporal resolution

- Human perception system (eye+brain) can perceive about 10 - 12 images per second as separate images.
- Persistence of vision
 - Image „remains“ in cortex for 1/25s
 - Neuron saturation



Film projector

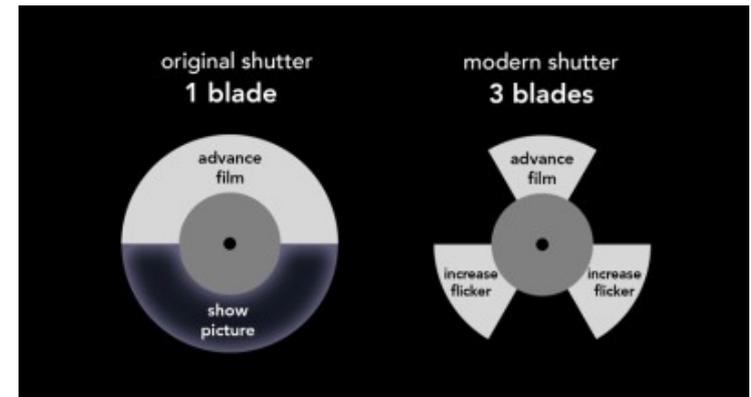
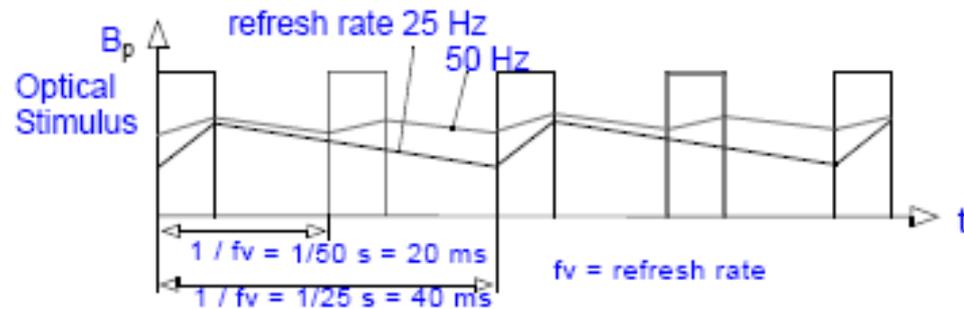
- For video illusion we need 16 images per second (FPS)
- ~1920: silent films use 20-26fps, 1930: 24fps



Why is the projection flickering?

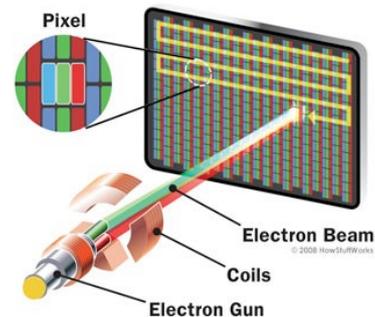
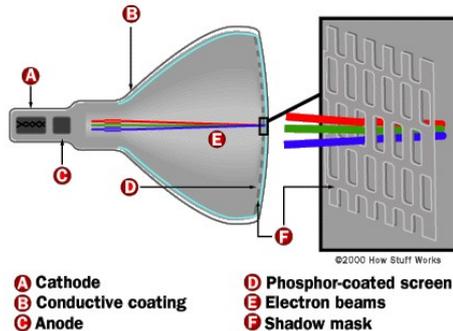
Flickering

- Shutter closed during film movement
- High illumination change - flickering
- Darker display - higher shutter frame rate



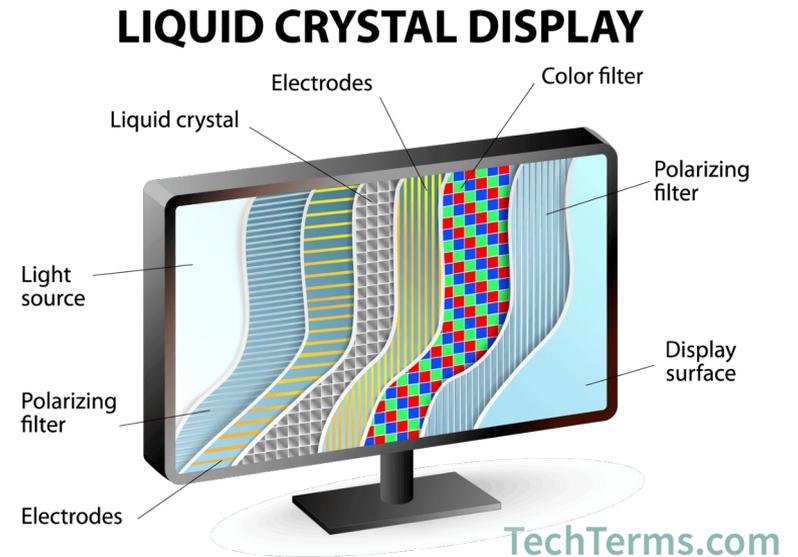
Cathode displays

- Electron beam traversing matrix of fluorescent particles
- When a particle (pixel) is hit, it briefly glows
- To maintain realism, the beam has to refresh the screen fast enough (refresh frequency)
- CRT monitors (<50Hz flickering) (~100Hz no flickering)



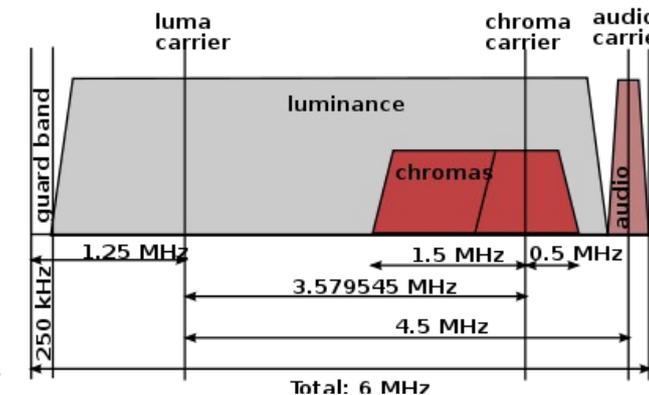
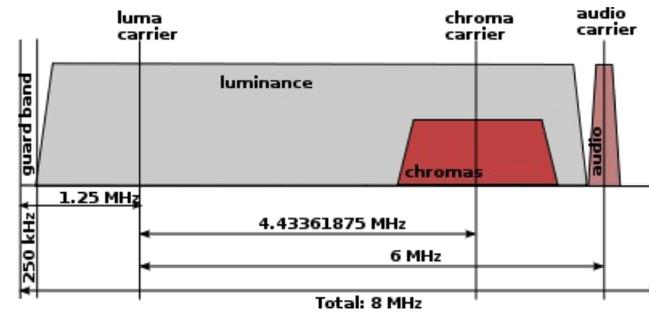
Flat panel displays

- Liquid crystal (LCD)
- Light-emitting diode (LED)
- Organic LED (OLED)
- (Plasma)



Analog television

- PAL
 - Phase Alternating Line
 - 625 lines per image
 - 25fps, aspect ratio 4:3, interlaced
 - YUV color space
- NTSC
 - Used in North America
 - YIQ color space
 - 525 lines (29.97fps), interlaced
 - Problems with NTSC: color tone shift due to geography and weather
 - To reduce channel cross-talk the chroma phase is alternating

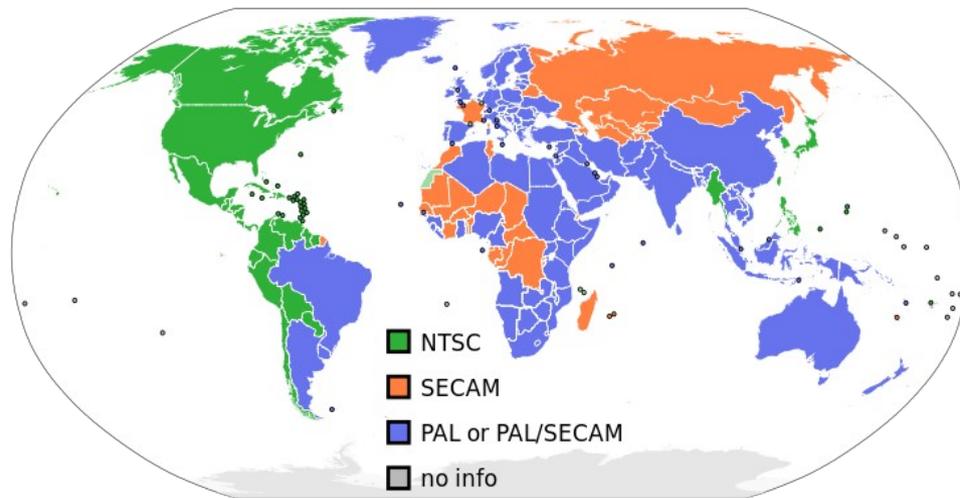


Encoding color

- Component video
 - Separate signals for color channels
 - Better image reproduction, no cross-talk
 - RGB, Digital video
- Composite video
 - Suitable for lower bandwidth
 - Luminosity and color mixed in common signal
 - Channel cross-talk
 - Analog TV: NTSC, PAL, SECAM



Analog television formats



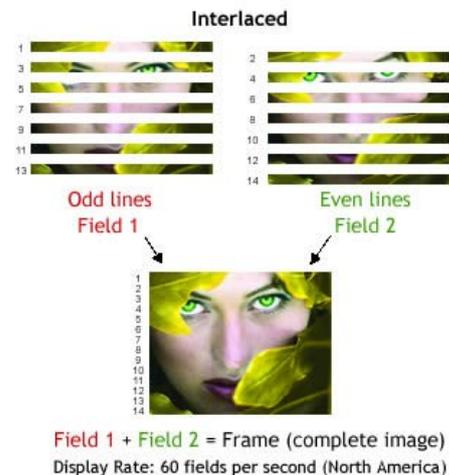
TV standard	FPS	# lines	Frequency band (MHz)	Channel allocation (MHz)		
				Y	I or U	Q or V
NTSC	29.97	525	6.0	4.2	1.6	0.6
PAL	25	625	8.0	5.5	1.8	1.8
SECAM	25	625	8.0	6.0	2.0	2.0

Digital video

- Storing on digital devices
- Direct manipulation (denoising, cutting, etc.)
- Inclusion in multimedia applications
- Direct access to different parts of videos
- Copying does not degrade quality
- Easier decoding, better noise tolerance

Encoding rows

- Interlaced
 - Split image into two - odd and even lines
 - Reduce flickering on analog displays
 - Less space
 - Quick changes cause »combing« effect
- Progressive
 - Store each image separately
 - More space



Interlaced video example



(a)



(b)



(c)

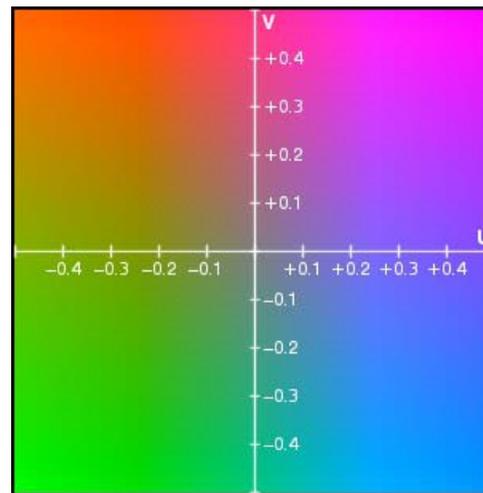


(d)

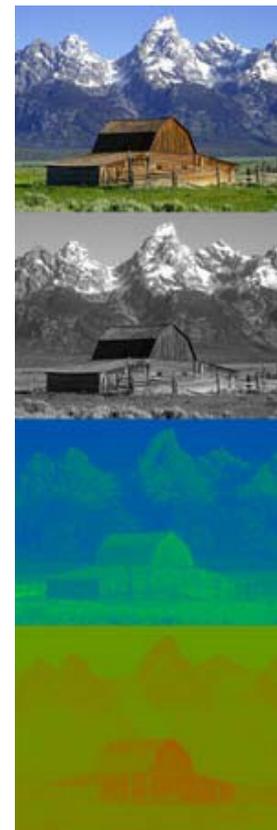
(a) Image from video, (b) field 1, (c) field 2, (d) difference between 1 and 2

Color coding

- De-correlated luminosity and color
- YUV, YIQ, YCrCb
 - Y is illumination
 - UV/IQ/CrCb are chroma components
- Conversion from RGB to YUV :
 - $Y=0.229R+0.587G+0.114B$
 - $U=0.492(B-Y)$
 - $V=0.877(R-Y)$

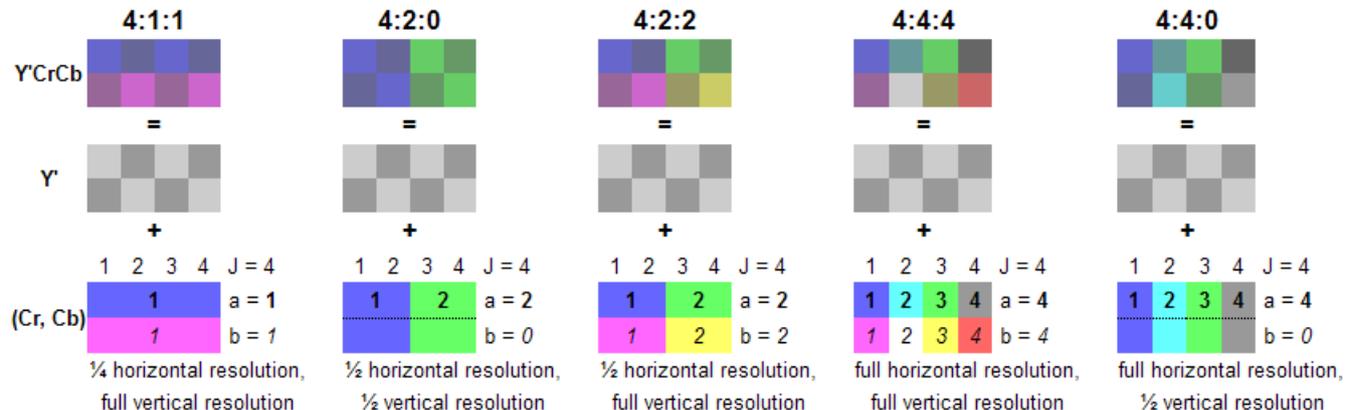


UV plane $Y=0.5$



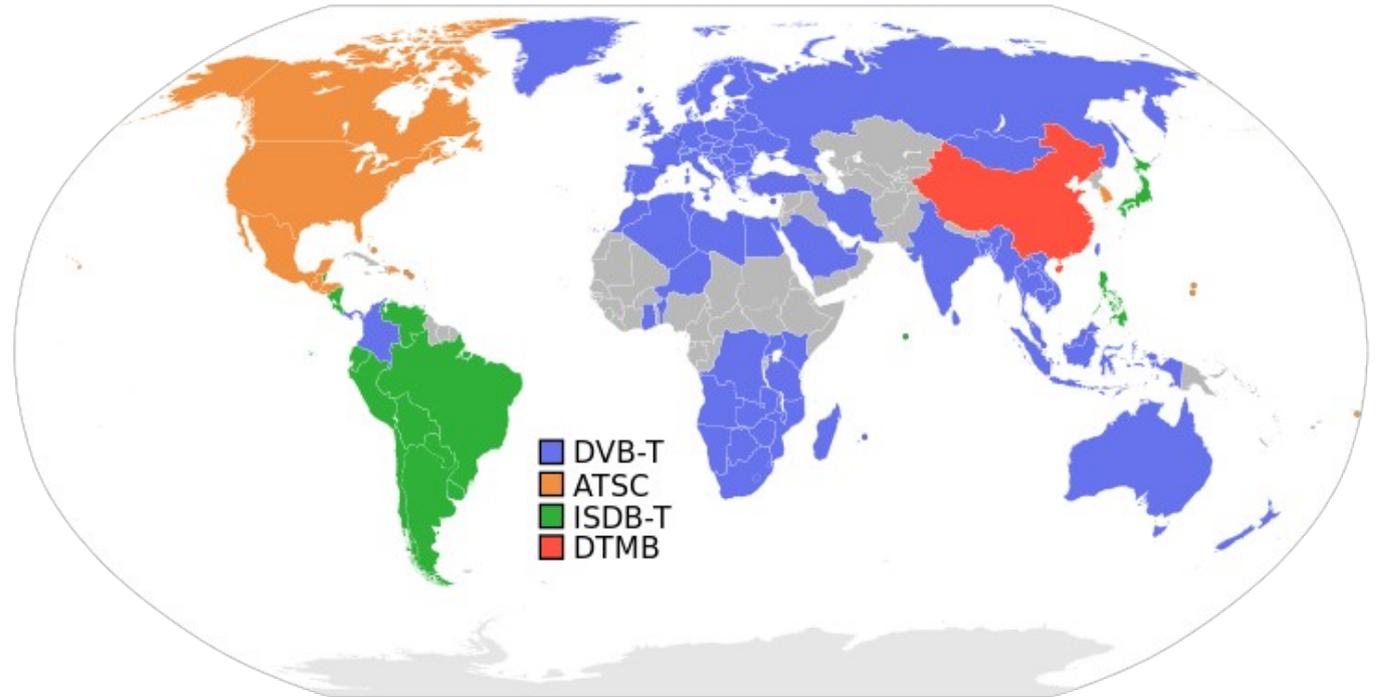
Color sub-sampling

- Humans are more sensitive to changes in illumination than in color
- Color can be sub-sampled - reduce size
- How many chroma values are actually retained
 - J: horizontal sampling frequency (region width, e.g. 4)
 - a: number of chroma samples (Cr, Cb) in the first line of J pixels
 - b: number of additional chroma samples in the second line of J pixels

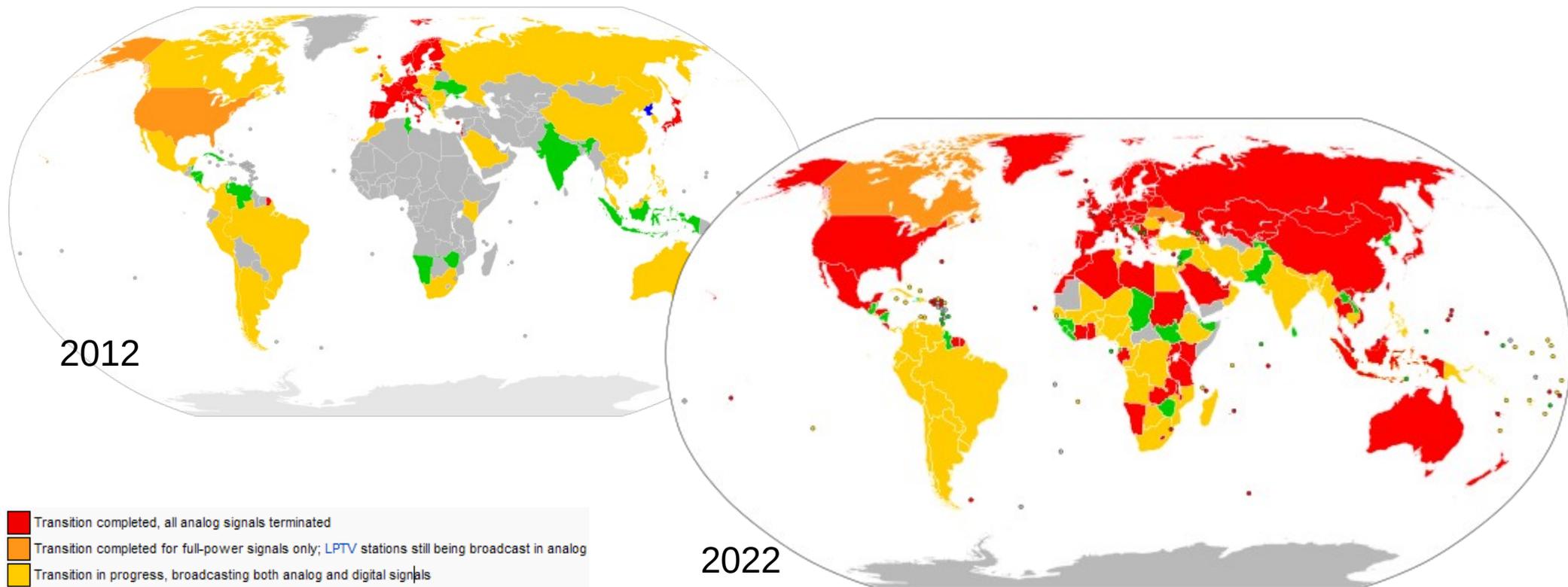


Digital terrestrial television (DTT)

Standards: DVB-T, ATSC, ISDB-T, DTMB



Transition to digital television



- Transition completed, all analog signals terminated
- Transition completed for full-power signals only; LPTV stations still being broadcast in analog
- Transition in progress, broadcasting both analog and digital signals
- Transition not yet started, broadcasting analog signals only
- Does not intend to transition, broadcasting analog signals only
- No information available

HDTV

- High resolution digital television
- Increase width of viewing angle
- First generation Sony (1970) - analog
- Standard for digital television
 - Advanced Television Systems Committee (ATSC)
 - Codec MPEG-2 for video compression
 - Resolution 1920×1080 (progressive)
 - Enables progressive and interleaved encoding (progressive default)
 - Aspect ration 16:9 (anamorphic)

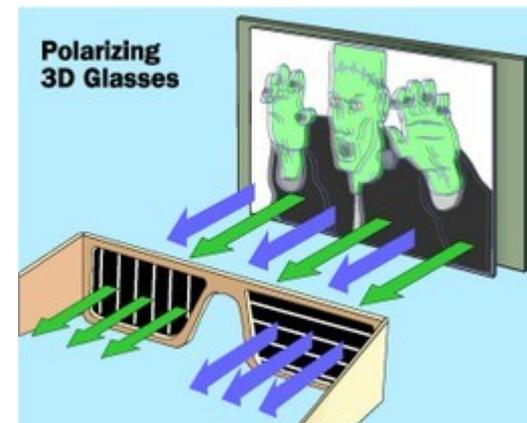
3D video

- Stereoscopic photography
 - Two images at two positions (50 mm to 75 mm apart)
 - Impression of a third dimension
- Video technology
 - Wearable technology
 - Autostereoscopy



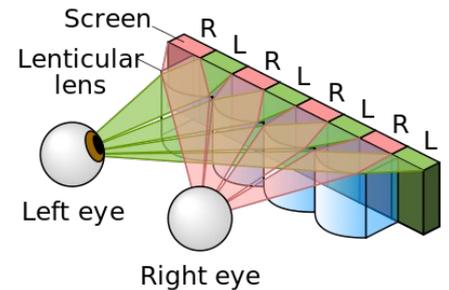
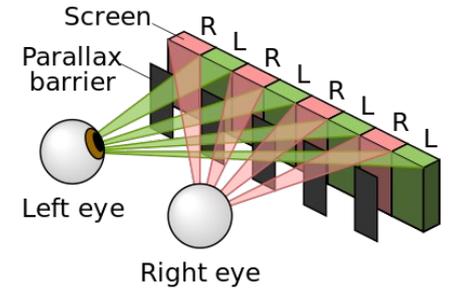
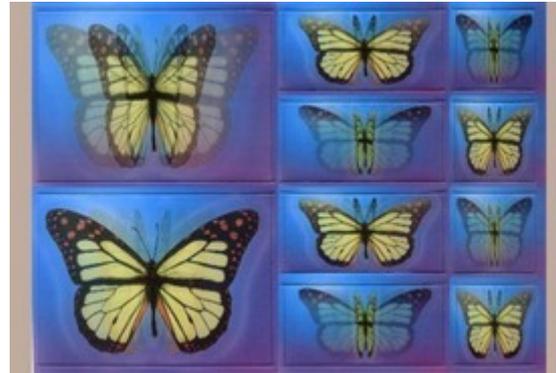
Wearable 3D video technology

- Anaglyph glasses (passive)
- Polarized glasses (passive)
- Binocular HMD (active)
- Active shutter glasses (active)



Autostereoscopy (Glassesless 3D)

- Eye/head tracking (active)
- Parallax barrier (passive)
- Lenticular lens (passive)

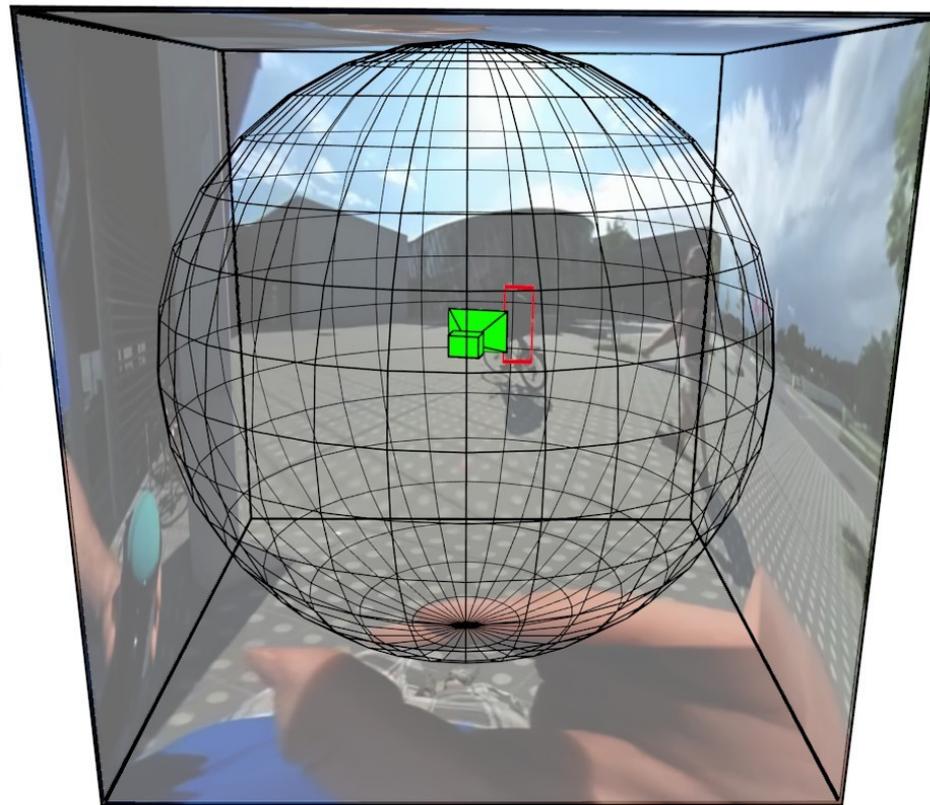


Problems with 3D video

- Technology
 - Resolution
 - Frame rate
 - Cross-talk
- Usefulness
 - Limited value
- Cost
- Health
 - Motion sickness
 - Headaches
 - Nausea
 - Disorientation

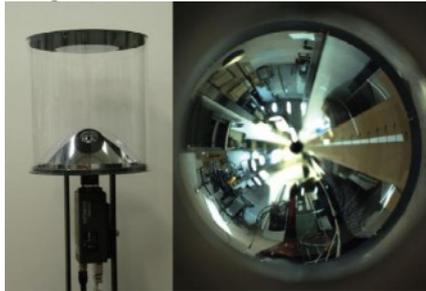
Omnidirectional video

- Single camera origin
- Projection sphere
- Interactive experience



Omnidirectional video acquisition

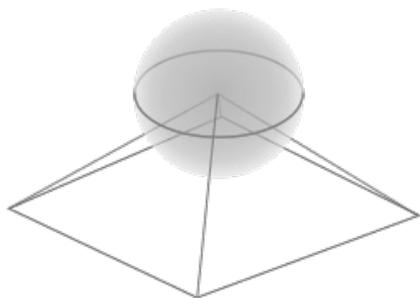
- Catadioptric camera
- Multi-camera
 - Wide-lens (less cameras, low resolution)
 - Narrow-lens (more cameras, high resolution)



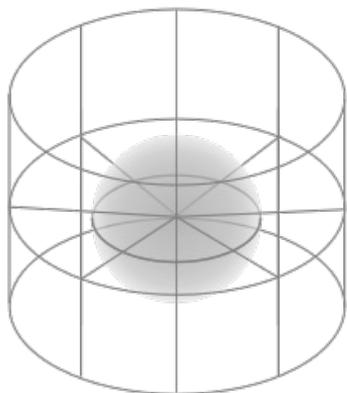
- Calibration (factory, post-processing)

Re-projection approaches

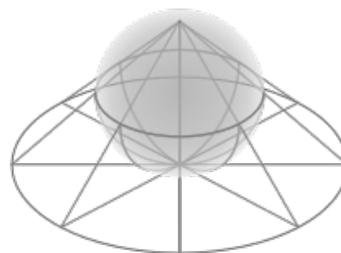
Flat



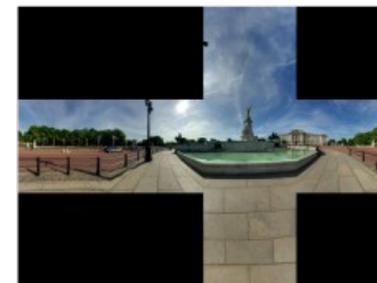
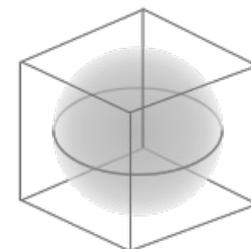
Equirectangular



Stereograph

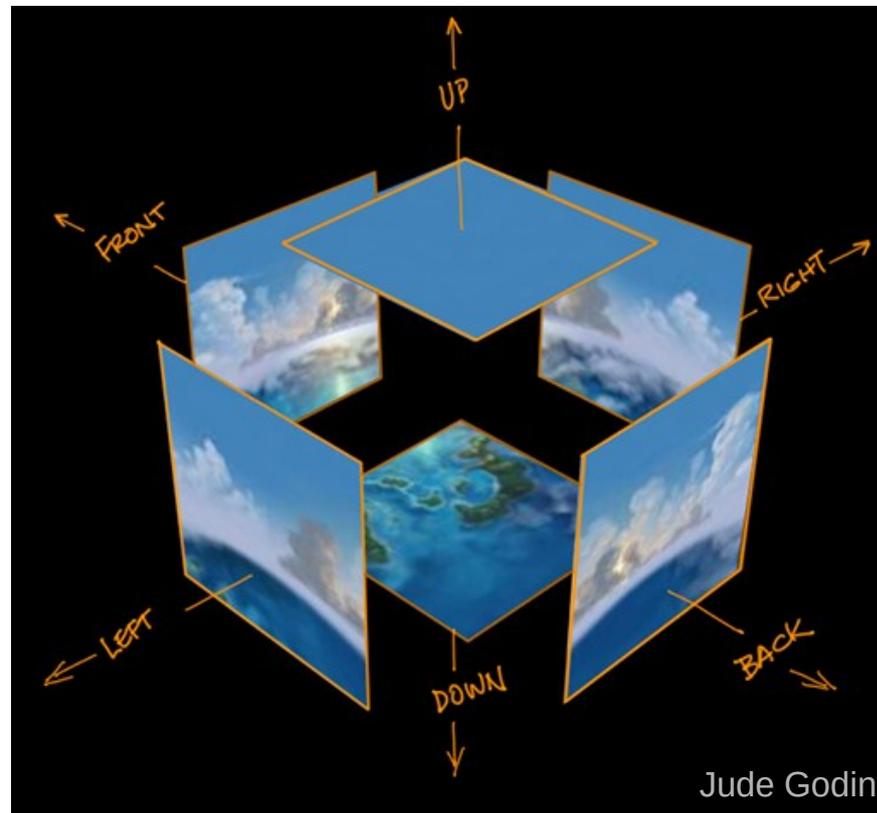


Cubemap



View generation

- Rendering
 - UV mapping
 - Cubemap
- Limitation
 - View angle
 - Resolution



Conclusion

- Interest
 - USA, 2016 - 90% think 360° video improves experience
- Use cases
 - Panoramas (aesthetic)
 - Live entertainment - BBC
 - Sports and tourism
 - Consumer-created (travel)

