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How to recognise video image sources

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Abstract

All sources of pictures have their own characteristics, limitations and flaws. Experience over many years of viewing images on high quality monitors has led to an appreciation of some of these problems. This note is intended as a summary of that experience and guidance to others who need to be able to assess what they are viewing.

Key words: video image recognition

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How to recognise video image sources

Although sounding somewhat Pythonesque, this problem is getting relevant now that HD up- and down- conversions are being made for programme sale. Recent experience with "Concorde", "Blue Planet" and "Rockface" has given a good opportunity to hone skills in this area. Basically there are three forms of signal source (film, video, graphics), each with several variants. The problem is how to identify each of them. So far, there is no 100% reliable solution, but experienced eyes can make an educated guess based on visible artefacts. The conclusions given here are based on experience and prejudice, as much as on measurement and proof. They are also generalisations, and there are techniques to circumvent almost all of them. Caveat emptor.

Picture Display

Type	Has great effect on perception of images. CRT is always best, plasma and front-projectors are short on contrast, back-projectors vignette (dark in the corners), LCD has strange colorimetry and small viewing angle. Each has individual advantages and disadvantages.
Size	Must be big enough to see the picture, subject to viewing distance.
Viewing distance	~6h for domestic viewing, minimum 3h for critical observation, maybe down to 1.5h for cinema type displays. Bigger displays need smaller viewing distances as multiples of picture height (h) and are more "involving".
Resolution	Must be able to resolve frequencies up to transmission bandwidth. 5.5MHz 625/50 (720 pixels), 4.2MHz 525/59.94 (550 pixels), HD/1080 (1920 pixels), HD/720 (1280 pixels).
Contrast and Brightness	The more the merrier, subject to black detail not being crushed and highlights clipped. 300:1 for domestic viewing, >2000:1 for best; peak white as high as feasible, 70cd/m^2 in cinemas, 150 in studios, 350 for domestic.
Ambient conditions	Affect image perception, subdued lighting is best (e.g. ITU Rec.500 spec.).
Sound	Silent pictures don't look as good as with relevant sound. And vice versa, sound is better with good pictures.

1 Film Characteristics

Motion	Judder, liked by Drama producers, generated in the eye by repeating images temporally to produce a video field-pair from each frame.
Sharpness	Mediocre. HF content is low level but goes way beyond video bandwidth.
Steadiness	Whole image tends to wander slightly due to positional errors in camera or telecine. Worse in small formats, old material, old equipment.
Lowlight detail	Well captured, detail not lost. Depends crucially on good lighting.
Highlight detail	Captured at low detail level (i.e. compressed), but distorted by halation in extreme cases (spreading of light in film-pack generating haloes around highlights).
Noise/Grain	Visible, less so when scene is well lit or on latest stock material.
Foreign Bodies	Dirt, hair, sugar (honest), etc. White if scanned from negative, black from print.
Saturation	Lowest in old stock. Low at high and low luma levels, highest in mid-greys.
Artefacts	None due to film itself.
Impression of Reality	Look/feel favoured by drama-makers, i.e. unreal.

1.1 16mm

Motion	Judders.
Sharpness	Soft. HF content poor.
Steadiness	Poor in old stock, good in modern stock and equipment.
Lowlight detail	Well captured, detail not lost when well lit.
Highlight detail	Captured at low detail level, but distorted by halation in extremes.
Noise/Grain	Visible, large size/level in old or fast stock (>100ASA). Reasonable in latest stock material (~50ASA) or when lighting absolutely right.
Foreign Bodies	Very visible, dirt, hair, sugar, etc. White if scanned from negative, black from print.
Saturation	Poor in old stock, better in modern slow stock.
Artefacts	None due to film itself.
Impression of Reality	Unreal look/feel, favoured by drama-makers.

1.2 35mm

Motion	Judders.
Sharpness	Not sharp or crisp.
Steadiness	Poor in old stock, good in modern stock and equipment.
Lowlight detail	Well captured, detail not lost when well lit.
Highlight detail	Captured at low detail level, but distorted by halation in extremes.
Noise/Grain	Visible in old or fast stock (>100ASA). Smaller in latest stock material (~50ASA) or when lighting very well controlled.
Foreign Bodies	Visible, dirt, hair, sugar, etc. White if scanned from negative, black from print.
Saturation	Poor in old stock, better in modern slow stock.
Artefacts	None due to film itself.
Impression of Reality	Unreal look/feel, favoured by drama-makers.

2 Video Characteristics

Motion	Fluid. Gritty if short shutter[1] or "film-motion"[2] applied.
Sharpness	Sharp in modern systems, maybe artificially crispened[3]. Soft in old/analogue material.
Steadiness	Perfect.
Lowlight detail	Crushed, detail lost unless precautions[4] taken.
Highlight detail	Clipped, detail lost unless precautions[4] taken.
Noise/Grain	Visible in old footage. Maybe completely absent in latest technology.
Foreign Bodies	None.
Saturation	Uneven. Overdone at high saturation, underdone at low end.
Artefacts	Cross-colour/luminance in coded material, aliasing in compressed footage. Ringing on edges if analogue processed.
Impression of Reality	Good, favoured by live programme-makers.

2.1 SD (625/50 or 525/59.94)

Motion	Fluid[1,2].
Sharpness	Sharp in best systems, artificially crispened[3] in cheaper systems (e.g. DV) or in DVE or standards conversion. Soft in old/analogue material.
Steadiness	Perfect.
Lowlight detail	Crushed, detail attenuated.[4]
Highlight detail	Clipped, detail lost.[4]
Noise/Grain	Visible in old material (e.g. coded PAL/analogue recording) especially in saturated colours. Maybe absent in latest technology (e.g. Digibeta, DV).
Foreign Bodies	None.
Saturation	Uneven. Overdone at high saturation, underdone at low end.[4]
Artefacts	Cross-colour/luminance in coded material, aliasing in compressed footage. Ringing on edges if analogue processed.
Impression of Reality	Good, favoured by live programme-makers.

2.2 HD (1080 or 720 at various field/frame rates)

Motion	Smooth.[1,2]
Sharpness	Very sharp, rarely artificially crispened.[3]
Steadiness	Perfect.
Lowlight detail	Maybe crushed, detail lost unless precautions taken.[4]
Highlight detail	Maybe clipped, detail lost unless precautions taken.[4]
Noise/Grain	Rarely visible.
Foreign Bodies	None.
Saturation	Good if lowlight/highlight handling is good.[4]
Artefacts	Possible aliasing in compressed footage. "Clean" pictures.
Impression of Reality	Excellent.

3 Graphics, Stills, Captions

Motion	Judders. Unless mimicking camera exposure time[1] and fields rendered individually[2].
Sharpness	Sharp.
Steadiness	Perfect.
Lowlight detail	Perfect.
Highlight detail	Perfect.
Noise/Grain	None. Adding some may increase impression of "reality".
Foreign Bodies	None.
Saturation	Perfect.
Artefacts	None.
Impression of Reality	Poor, too clinical. Stills look frozen.

Footnotes

1 Shutter	Normally, exposure time=1/field rate, individual fields may blur on motion. Shorter shutters often used in sports or for film-look to sharpen moving scenes, or to limit light level. Gives sharp slow-motion but gritty at normal speed.
2 Film-motion	Mimics film exposure. Some cameras can shoot in "pro-scan" mode at frame rate (25fps, 180^{o}=50% shutter and repeated images). Generates film-like motion judder, more objectionable with really sharp video pictures than with soft film.
3 Aperture Correction	Artificial sharpness, edge enhancement. Originally to make up for soft lenses. Strictly not needed with best new cameras. If overdone, produces sharp haloes around contrasty edges. Done judiciously can still improve best pictures. Can be applied to film in telecine as well. Bad in standards-converted material when derived from and applied in interlaced fields, gives black borders to contrast edges.
4 Gamma Correction	Normally follows standard curve (e.g. BBC, Rec.709); limited slope at black (crushes shadows), clips at peak white. Camera may have controls/menus to modify curve, most important near black (extra gain) captures lowlight detail and white (knee) to compress and capture overloads.

Post Production effects

Digital Video Effects (DVE)	Any change of picture size/shape/position. Can "burn-in" interlace effects, e.g. jagged sloping edges. Will change the scale of any artefacts such as aperture correction.
Film Look	Specialised case of DVE. Applied to video to give "Film-Look" motion judder. At worst, throws away alternate fields; at best, uses S&W ARC. Always reduces resolution (by 10% to 50% depending on technique), stamps in interlace artefacts that the eye normally rejects. Can be eliminated in recent video cameras by shooting in "progressive" mode.
Aspect Ratio conversion	Specialised case of DVE. Applied to 4:3 footage to use it in 16:9 programmes. Crops vertically, uses only 432 lines of 576, stretches to fill raster anamorphically. Always reduces resolution (by at least 25%), stamps in interlace artefacts that the eye normally rejects. Can be combined with Film-Look processing for minimum horror.
Speed changes	Both ways, up and down. Most often applied to film because cameras can be run at silly speeds (40 and 60fps common in 16mm), 1000fps not uncommon, and less than 1fps increasingly common. Images always have wrong shutter duration for good motion, still frames look too sharp.
Standards conversion	Specialised case of speed change and DVE, only for SD video material (between 625/50Hz and 525/59.94Hz). Image rate changes but time not compressed or dilated. Early attempts poor (jerky motion) but latest (very expensive) systems almost transparent. Up- and down-conversion between SD and HD does same but usually much better (and much more expensively). Even latest motion-adaptive conversion can be fooled by non-sharp moving pictures. Spacing of original camera vertical aperture correction (black lines above/below contrasty edges) preserved, so may be excessive when lines/field rate changed (e.g. 525 [480] to 625 [576]).
Composite coding	PAL or NTSC. Cross colour (spurious colouring of patterns), low colour spatial resolution exacerbated by aperture correction.