

Higher Frame Rates for more Immersive Video and Television

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Frame rate

- TV frame/field rates were chosen over 70 years ago.
- They were chosen to:
 - exceed the threshold for apparent motion
 - avoid visible flicker (on small screens)
 - avoid interaction with the mains frequency
 - provide a way of showing cinema film

Standard frame/field rates

- Current 50/60Hz TV was a match to
 - standard definition pictures
 - and smaller CRT displays
- Problems arise with
 - larger displays
 - increased picture resolution
 - sample-and-hold display technology

Loss of detail on moving objects



Motion Portrayal at 50/60Hz

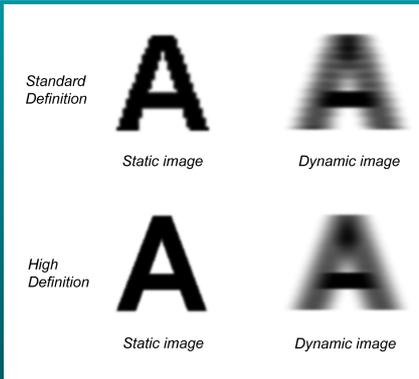
- The portrayal of motion is a trade off between
 - motion blur (long shutter)
 - temporal aliasing (short shutter), leading to jerky motion and spoked wheels running backwards
 - Short shutter also means less light, and hence increased noise

Dynamic Resolution at 50/60Hz

- When the camera pans the entire High Definition scene becomes blurred - for example when following the action during a football match
- As you increase the resolution so the rate of panning has to be reduced to keep the blurring under control

Dynamic Resolution at 50/60Hz

The dynamic resolution of HDTV is no better than SD



Impact on the Viewer

- Where there is a large difference between the resolution of a static and dynamic picture, this can lead to a feeling of nausea
- Therefore the higher the *static* resolution, the higher the *dynamic* resolution must be for comfortable & lifelike images

Up-converting Displays

- Create intermediate images using motion prediction
- But this is not High Frame Rate TV
 - Cannot reduce motion blur captured in camera
 - Cannot predict complex motion, cuts and cross-fades
- To make motion rendition more lifelike we need - higher frame rates in the camera
 - higher frame rates for distribution
 - and higher frame rates in the display

Higher Frame Rates

- We would suggest that:
 - if SD is acceptable at 50Hz
 - then full HDTV needs around 100-150Hz
 - as resolution increases, we may need 300Hz
- 300Hz is easy to convert to 50 or 60Hz and is compatible with mains frequencies

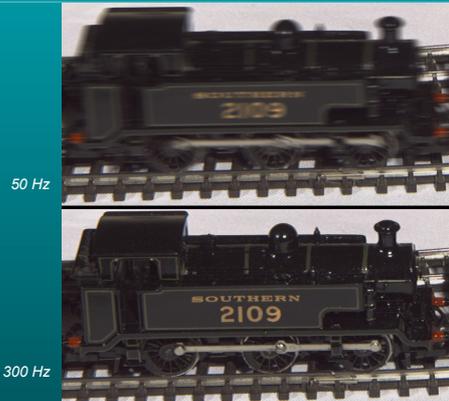
It may only be needed in the camera, not delivery?

Demonstration of High Frame Rate TV

- At IBC 2008, on the EBU Village
 - Video shot 1920 x 1080 at 300Hz
 - down-converted to display at 1400 x 788 100Hz



Demonstration of High Frame Rate TV



Work at NHK (Japan's National Broadcaster)

- Experiments conducted to determine the frame rate for future Ultra-High Definition TV system
 - Require > 80 fps to prevent flicker
 - Require >100 fps to merge motion in eye
 - Require shutter opening < 1/320 second to prevent blur
- **Proposal of 120 fps for UHDTV**

Work at Sony

- Tested sequences between 60 & 480 fps
 - Require ~250 fps to prevent jerkiness
 - Require ~250 fps to prevent blur
- Proposal of 240 fps for compatibility with 24 and 60 fps
- Prototype 4k x 2k resolution, 240 fps stereoscopic camera and display

Frame rates in the cinema

- Showscan (60 fps) is 30 years old
 - Costly due to film consumption
 - Only really used for simulator rides
- 3D cinema films highlight motion judder
 - James Cameron considering 48 or 60 fps for *Avatar 2 & 3*
 - Peter Jackson is already shooting *The Hobbit* at 48 fps

Ways to achieve higher frame rate

We need to consider the whole TV system to understand how higher frame rates could be accommodated

Transmission data rate:

- Fewer I-frames (longer GOP length) whilst still retaining $\frac{1}{2}$ s GOP
- Better noise masking at higher frame rates
- Sharper input frames = better motion prediction
- Less difference between static & moving images = better prediction

So will be more efficient to code

Conclusions

- Frame rate needs to increase alongside higher spatial resolution
- There is now a lot of evidence that higher frame rates improve the immersive experience

Thank you

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