HIGH DYNAMIC RANGE (HDR) VIDEO

Digital Preservation
Cine-GT 1807
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OUTLINE

• Introduction
• Production
• Distribution
• Preservation
• 8K
  • 7869 x 4320 pixels
  • Vimeo uploads already available

• 4K
  • 3840 x 2160 pixels
  • 4K Cinema
  • 4096 x 2160 pixels

• 2K
  • Full-HD
COLOR

- Color Depth
  - 8-bit
  - 10-bit
  - 12-bit

- Color Gamut
  - BT.709
    - 36% of the visible color spectrum
  - DCI-P3
    - Intermediate standard
    - 62%
  - BT.2020
    - Exceeds the gamut of actual monitors
    - 76%
DYNAMIC RANGE

- Ratio of maximum to minimum light intensity
- Measured in f-stops

- Film captures 15.5 f-stops
- Experimental film captured 26 f-stops
- Rocket launch is 20 f-stops

- HDR over 16 f-stops
- SDR less than 10 f-stops
HDR VIDEO

• Different from HDR still images
• First displays in 2004
• First cameras in 2009
• Greater contrast ratio
• Brighter highlights
• Improved detail in dark areas
• Measured in nits (candela per square meter, cd/m²)
PRODUCTION

- Commercial camera systems capture 18 f-stops or less
- Cameras have been capturing HDR since 2010
TRANSFER FUNCTION AND HDR METADATA

- HDR display format is determined by its Transfer Function (EOTF)
  - “The description of how to convert the signal's carrier (analog voltage, film density, or digital code values) to optical energy” - SMPTE

- End-to-end control over image using unique HDR metadata
  - Embedded during color-grading and mastering
  - Static Metadata
  - Dynamic Metadata
HDR TRANSFER FUNCTIONS

- Hybrid Log Gamma (HLG)
  - Designed by BBC and NHK
  - Maintains backwards compatibility with SDR
  - No display metadata needed

- Perceptual Quantizer (PQ)
  - Open
    - HDR10 Static Metadata
    - HDR10+ Dynamic Metadata
  - Proprietary
    - Dolby Vision Dynamic Metadata
CODECS

• Uncompressed
  • Single frame at 4K = 95 MB
  • One minute at 30 fps = 167 GB

• HEVC / H.265
  • MPEG standard
  • Supersedes AVC / H.264

• VP9
  • Youtube open source
  • Competes with HEVC
MEDIAINFO TESTS

Video Transfer Characteristics
- PQ
- HLG

Video Color Primaries
- BT.2020

Video Format
- HEVC
• Streaming
• Discs
• Movie Theatres
• Broadcasting
<table>
<thead>
<tr>
<th><strong>Services</strong></th>
<th><strong>Devices</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Netflix</td>
<td>Roku</td>
</tr>
<tr>
<td>Amazon</td>
<td>Apple TV</td>
</tr>
<tr>
<td>Vudu</td>
<td>Amazon Fire</td>
</tr>
<tr>
<td>iTunes</td>
<td>Google ChromeCast</td>
</tr>
<tr>
<td>Vimeo</td>
<td>Smart TVs</td>
</tr>
<tr>
<td>Youtube</td>
<td>UltraHD Disc Players</td>
</tr>
</tbody>
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UHD DISCS

• Firsts discs in March 2016
• Dolby Vision discs in June 2017

• HEVC
• 4K
• HDR
• High frame rate
CINEMA

- Dolby Cinema
- 2 laser projectors
- 77 Locations in the USA
- AMC Empire 25 in Manhattan
Broadcasting

- Issues
  - Backwards compatibility
  - Reliance on metadata

- HLG
  - Japan and Europe
  - Backwards compatible with SDR displays

- ATSC 3.0 standard in USA
  - Over-the-air 4K, HDR, BT.2020
  - Approved by FCC in November 2017
HDR IN ARCHIVES

• CUNY TV
  • No HDR production
  • Would not make a difference in the archive’s workflow

• Human Rights Watch
  • Some 4K content
  • Distribution in 1080i