H.264/AVC analysis of quality in wireless channel

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1 Video transmission
   - Video transmission schema
   - Error protection for video
   - Model of channel
   - Improved model for simulation

2 Testing equipment
   - Methods
   - PSNR vs. SSIM
   - Video encoder

3 Research
   - Results & bits classification
   - RD, Claire
   - RD, Trueman
Outline

1. Video transmission
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Video transmission schema

- Transmitters and receivers
- Wire and wireless channels
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Error protection for video

- Error protection for stream
  - Effective
  - No priority
Error protection for video

- Error protection for stream
  - Effective
  - No priority
- Error protection during video encoding (e.g. RVLC)
  - Partly protection
  - Compatibility loosing
Error protection for video

- Error protection for stream
  - Effective
  - No priority
- Error protection during video encoding (e.g. RVLC)
  - Partly protection
  - Compatibility loosing
- Idea! Error protection for separated substream ⇒ Protection depends on substream significance
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Model of channel

- Video encoder and decoder
Model of channel

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- Model of channel to produce errors with known distribution
Model of channel

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- Model of channel to produce errors with known distribution
- Statistics acquisition software
Model of channel

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⇒ Not useful
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Improved model for simulation

- Join channel model and decoder
  - The encoder’s source is not change (+compatibility, +performance)
Improved model for simulation

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  - Only one copy of compressed video-sequence is required for all experiments (+performance)
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  - Decoding is more faster than encoder (+performance)
Improved model for simulation

- Join channel model and decoder
  - The encoder’s source is not change (+compatibility, +performance)
  - Only one copy of compressed video-sequence is required for all experiments (+performance)
  - Decoding is more faster than encoder (+performance)
- **Limitation**: The error positions are vary (*easy to avoid*)
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Methods

- Rate-distortion compare
Methods

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- The objective metrics
  - PSNR (Peak Signal-to-Noise Ratio)
  - SSIM (structural similarity)
Methods

- Rate-distortion compare
- The objective metrics
  - **PSNR** (Peak Signal-to-Noise Ratio)
  - SSIM (structural similarity)
- Video sequences
  - Claire (slow motion)
  - Trueman (fast motion)
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## PSNR vs. SSIM

<table>
<thead>
<tr>
<th>PSNR</th>
<th>SSIM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MSE based</strong></td>
<td><strong>Compares intensity group of pixels</strong></td>
</tr>
<tr>
<td>Compares pixels</td>
<td><strong>Uses window</strong> (size $M \times M$) for compare</td>
</tr>
<tr>
<td><strong>Low complexity</strong>  $\Theta(w \times h)$ and low memory usage (some cells)</td>
<td>High complexity $5O(M \times w \times h) + 17\Theta(w \times h)$ and high memory usage $\approx 7 \times w \times h$ cells</td>
</tr>
<tr>
<td>The high bound is undefined ($+\infty$)</td>
<td><strong>Normalized</strong> from 0 (worst) to 1 (best)</td>
</tr>
<tr>
<td><strong>Same behavior</strong> for high bitrates</td>
<td></td>
</tr>
<tr>
<td>Prefer for high bitrates usage</td>
<td><strong>Large proportional range for low bitrates</strong></td>
</tr>
</tbody>
</table>
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Video encoder

Video encoder

- Profiles from cellular up to home theater
Video encoder

- Profiles from cellular up to home theater
- Simulation options
  - VLC instead CABAC
  - RTP (RFC1889) encapsulation
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Results & bits classification

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- Probability of channel error more than $10^{-6}$ halts decoder
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  - Fatal – halts decoder
  - Nonfatal – corrupt image
Results & bits classification

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⇒ The quantity of fatal bits determine the significance of the substream
Results & bits classification

- H.264 has not error protection
- Probability of channel error more than $10^{-6}$ halts decoder
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  - Fatal – halts decoder
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⇒ The quantity of fatal bits determine the significance of the substream
⇒ Code protection options depend on significance of the substream
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Thanks

- Any questions?