Adaptive Rate Control Algorithm for SHVC: Application to HD/UDH

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1. Context
- SHVC: a promising technology
  - Scalable video coding
  - Substantial compression gains
  - Backward compatibility
- Adaptive Rate Control (ARC): Adjusts encoding parameters to reach a targeted bitrate
- New services introduction: Provide UHD through EL
- While keeping HD service in BL

2. Related work and motivations
- Impact of the bitrate ratio on performance?
  - Defined as \( \tau = R_{BL}/(R_{BL} + R_{EL}) \)
  - Explored in our previous work \( \tau \) has a strong impact!
- Existing ARC approaches:
  - Fine Granular Scalability in SVC
  - Enable fast transcoding
  - Separated bitrate per layer
  - Do not exploit \( \tau \)

3. Proposed method
- Encoding parameters
  - Global bitrate: \( R_G = R_{BL} + R_{EL} \)
  - Authorized ratio interval: \( \Phi = [\tau_{\min}, \tau_{\max}] \)
- Goal
  - Adjust the bitrate ratio \( \tau \) in \( \Phi \)
  - To optimize the objective coding performance

4. Experiments and analysis
- Data set
  - EBU UHD-1 dataset
  - Ten 3840x2160p40 8-bits 10-seq sequences
  - HD versions built with SHM-9.0 down-sampler
- Encoding parameters
  - \( \Phi = [\tau_{\min}, \tau_{\max}] \) for ratio interval
  - \( \tau_{\min} = \frac{2}{k+2} \) which is the ratio achieved by using the CTC
  - \( R_E \in \{5, 10, 15, 20\} \) Mbps
- Two approaches are compared to the single-layer (BD-BR)
  - Our method integrated in the SHM-9.0 \( \rightarrow G_{ARC} \)
  - Native SHM-9.0 working at fixed ratio \( \tau_0 \rightarrow G_{Ref} \)
- Observations:
  - Bitrate overhead reduced from 20% to 16%.
  - With a crossed BD-BR improvement of 4.25%.
  - Best method for 9 in 10 sequence.

**Sequence** | \( G_{Ref} \) | \( G_{ARC} \) | \( G_X \)
---|---|---|---
Candle Smoke | 16.97% | 12.89% | 6.08%
Fountain Lady | 15.68% | 16.16% | +0.48%
Lupo Boa | 11.31% | 10.46% | 0.85%
Lupo Confetti | 15.35% | 11.60% | 1.75%
Park Dancers | 23.80% | 22.22% | 1.58%
Pendulus Wide | 30.56% | 26.49% | 4.07%
Studio Dancer | 18.92% | 14.57% | 4.35%
Waterfall Pan | 20.72% | 16.61% | 6.11%
Wind Wool | 19.64% | 9.83% | 9.81%
Veget Fruits | 51.53% | 22.91% | 8.42%
Average | 20.43% | 16.17% | 4.25%

**Next Step** | Quality and bitrate requirements per layer