Performance Analysis of DIRAC PRO with H.264 Intra frame coding

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What is Dirac?

- Hybrid motion-compensated video codec developed by BBC.
- Uses modern techniques - wavelet transforms, arithmetic coding.
- Open technology – no license fees.
- Easily recreated for new platforms.
- Applications - HDTV to web streaming.
**DIRAC**

- Open technology - no licensing costs.
- Flexible, ease of operation over many applications.
- Capable of compressing high resolution files.
- More freedom for future implementations, more scope to improve performance.
- Comparable to other codecs despite simple toolset.
- Relative simplicity and clean architecture supports high performance.
- Good quality at low bit rates, lower costs.
Dirac - Architecture

Diagram:

1. Motion compensation
2. Transform, scaling and quantization
3. Scaling and inverse transform
4. Motion estimation
5. Entropy coding

Flow:
- Motion compensation -> Transform, scaling and quantization
- Scaling and inverse transform -> Motion estimation
- Motion estimation -> Entropy coding
- Entropy coding -> MV data
- MV data -> Scaling and inverse transform
- Scaling and inverse transform -> Transform, scaling and quantization
- Transform, scaling and quantization -> Motion compensation
Dirac - Wavelet Transform

- More efficient than block transforms with still images.
- Operates on entire picture.
- Repeated filtering of signals into low- and high-frequency parts.
- Horizontal and vertical filtering for 2D signals.
- Logarithmic frequency decomposition into sub-bands at each stage.
Wavelet Transform contd..

- Packs most information into low frequency sub-bands - compression achieved.
- Process repeated to achieve higher levels of wavelet transform.
- Coded picture free from block artifacts, superior moving images.
Wavelet Transform contd..
Stages of a wavelet transform
Intra & Inter prediction

Three types of frames: I (Intra), L1 (Level 1) and L2 (Level 2).

Intra frames - coded without reference.

Inter frames - L1, L2 frames coded with reference to previously coded frames. L1 frames used as temporal references for other frames, L2 frames are not. Each frame predicted from up to two reference frames.
History of H.264

History of H.264 / MPEG-4 part 10

- ITU-T Q.6/SG16 started work on H.26L (L: Long Range)
- July 2001: H.26L demonstrated at MPEG (Moving Picture Experts Group) call for technology
- December 2001: ITU-T VCEG (Video Coding Experts Group) and ISO/IEC MPEG started a joint project – Joint Video Team (JVT)
- May 2003: Final approval from ISO/IEC and ITU-T
- The standard is named H.264 by ITU-T and MPEG-4 part 10 by ISO/IEC
- Fidelity Range Extensions (August 2004) Amendment 1
- Transport of MPEG-4 AVC on MPEG-2 TS Amendment 3
Purpose of H.264

- Higher coding efficiency than previous standards, MPEG-1,2,4 part 2, H.261, H.263
- Simple syntax specifications
- Seamless integration of video coding into all current protocols
- More error robustness
- Various applications like video broadcasting, video streaming, video conferencing, D-Cinema, HDTV
- Network friendliness
- Balance between coding efficiency, implementation complexity and cost - based on state-of-the-art in VLSI design technology
H.264/MPEG-4 AVC architecture
Specific coding parts for the Profiles

- **Extended Profile**
  - Data Partitioning
  - SI slice
  - SP slice

- **Main Profile**
  - CABAC
  - B slice
  - Weighted prediction
  - P slice
  - CAVLC
  - Arbitrary slice order
  - Flexible macroblock order
  - Redundant slice

- **High Profile**
  - Adaptive transform (4x4 or 8x8)
  - HVS weighting matrices
  - Residual color transform
  - Predictive lossless coding
  - Error Resilience Tools
Profiles and Levels for particular applications
Profile: The standard defines various sets of capabilities which are referred to as Profile.
Four profiles: Baseline, Main, Extended and High.

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Bit Rate Vs PSNR

Bit Rate Vs MSE

H.264
DiracPRO

H.264
Dirac
Highway_qcif

Bit Rate Vs SSIM

H.264
Dirac-PRO
Bit Rate Vs PSNR

Bit Rate Vs MSE
Bit Rate Vs SSIM

SSIM

Bit Rate

H.264
Dirac-PRO
highway_cif

Bit Rate Vs PSNR

Bit Rate Vs MSE
Bit Rate Vs SSIM

- SSIM values: 0.82, 0.84, 0.86, 0.88, 0.9, 0.92, 0.94, 0.96, 0.98
- Bit Rate values: 146.57, 427.29, 1846.8

Lines correspond to:
- H.264
- Dirac-PRO
Conclusion

As Dirac Pro is royalty free software the H.464 Intra frame and Dirac Pro has comparable results.
References

References