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Course: EE5359 – Multimedia Processing

Study and Performance Comparison of HEVC and H.264 Video CODECs

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Scope of the Project

• This project aims at studying the state-of-the-art High Efficiency Video Coding (HEVC) [12] and H.264/Advanced Video Coding (AVC) [13] video codecs and gaining an understanding of various techniques in these codecs such as prediction, transform, quantization and coding.

• Comparison of these video codecs based on various performance metrics such as computational time, PSNR, SSIM, BD-Bitrate and BD-PSNR will be carried out.

• HM 13.0 and JM 18.6 reference software for HEVC and H.264 respectively will be used for this purpose.
Introduction to HEVC

- High Efficiency Video Coding (HEVC) [12] is an international standard for video compression developed by a working group of ISO/IEC MPEG (Moving Picture Experts Group) and ITU-T VCEG (Video Coding Experts Group).

- The main goal of HEVC standard is to significantly improve compression performance compared to existing standards (such as H.264/Advanced Video Coding [13]) in the range of 50% bit rate reduction [5].

- HEVC is designed to address existing applications of H.264/MPEG-4 AVC and to focus on two key issues: increased video resolution and increased used of parallel processing architectures [5].
Block Diagram of HEVC CODEC [17]
Steps in HEVC Encoding

- Partitioning each picture into multiple units
- Predicting each unit using inter or intra prediction, and subtracting the prediction from the unit
- Transforming and quantizing the residual (the difference between the original picture unit and the prediction)
- Entropy encoding the transform output, prediction information, mode information and headers.
Block Diagram of HEVC Encoder [9]
Steps in HEVC Decoding

- Entropy decoding and extracting the elements of the coded sequence
- Rescaling and inverting the transform stage
- Predicting each unit and adding the prediction to the output of the inverse transform
- Reconstructing a decoded video image.
Block Diagram of HEVC Decoder [31]
H.264/Advanced Video Coding Standard


- The main goals of the H.264/AVC standard were to enhance compression performance and provision of a network-friendly video representation addressing conversational (video telephony) and non-conversational (storage, broadcast, or streaming) applications [8].
Block Diagram of H.264 CODEC [18]
Encoding in H.264

• The encoder processes a frame of video in units of a macro-block (16x16 displayed pixels). It forms a prediction of the macro-block based on previously-coded data, either from the current frame (intra prediction) or from other frames that have already been coded and transmitted (inter prediction). The encoder subtracts the prediction from the current macro-block to form a residual.

• A block of residual samples is transformed using a 4x4 or 8x8 integer transform, an approximate form of the Discrete Cosine Transform (DCT).

• The output of the transform, a block of transform coefficients, is quantized, i.e. each coefficient is divided by an integer value.

• The values produced in these processes are encoded to form the compressed bit stream.
Block Diagram of H.264 Encoder [10]
Decoding in H.264

• A video decoder receives the compressed H.264 bit stream, decodes each of the syntax elements and extracts the information such as quantized transform coefficients, prediction information, etc.

• This information is then used to reverse the coding process and recreate a sequence of video images.
Block Diagram of H.264 Decoder [10]
Comparison of HEVC and H.264 Coding Tools [20]

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Metrics to be used for comparison of CODECs

- Peak Signal to Noise Ratio (PSNR)
- Structural Similarity Index (SSIM)
- BD-Bitrate
- BD-PSNR
- Computational time as a measure of implementation complexity
Profiles for Comparison

The following profiles for HEVC and H.264 respectively will be used for comparison in this project:

• HM 13.0 main profile [5]
• JM 18.6 high profile [8]
Test Sequences

The following test sequences [23] are used for the study in the project:

RaceHorses_416x240_30.yuv  BasketballDrill_832x480_50.yuv
Test Sequences

KristenAndSara_1280x720_60.yuv

Kimono1_1920x1080_24.yuv
References


References (Continued)


References (Continued)


Acronyms and Abbreviations

AVC: Advanced Video Coding.

BD-BR: Bjontegaard Delta Bitrate.

BD-PSNR: Bjontegaard Delta Peak Signal to Noise Ratio.

CABAC: Context Adaptive Binary Arithmetic Coding.

CTB: Coding Tree Block.

CTU: Coding Tree Unit.

CU: Coding Unit.

DBF: De-blocking Filter.

DCT: Discrete Cosine Transform.

HEVC: High Efficiency Video Coding.

HM: HEVC Test Model.


Acronyms and Abbreviations

JCT-VC: Joint Collaborative Team on Video Coding.
JM: H.264 Test Model.
JPEG: Joint Photographic Experts Group.
MPEG: Motion Picture Experts Group.
MSE: Mean Square Error.
PB: Prediction Block.
PSNR: Peak Signal to Noise Ratio.
QP: Quantization Parameter
SAO: Sample Adaptive Offset.
SSIM: Structural Similarity Index.
TB: Transform Block.
TU: Transform Unit.