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JVET-V0093
AHG9:Film grain estimation and film grain synthesis for VVC Film grain characteristics SEI message, film grain estimation and film grain synthesis modules

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April 2021

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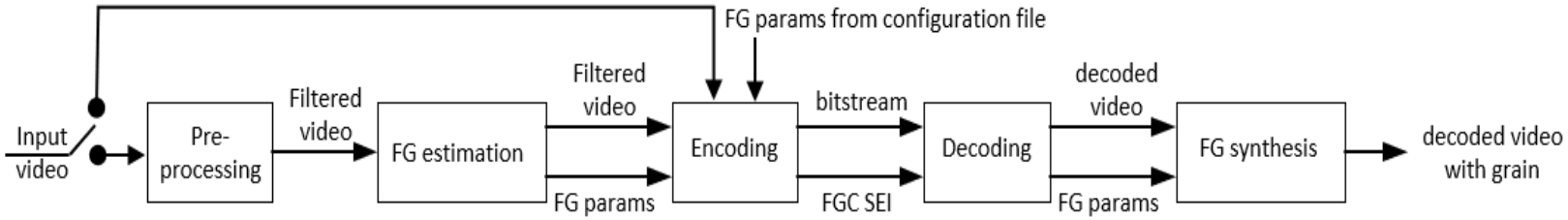
Proposal

- Proposal is related with
  - Film grain characteristics SEI message
  - Film grain synthesis module
  - Film grain analysis (parameter estimation) module

- Film grain is sometimes referred as desirable noise
- Film grain is a desirable feature in video production
- Film grain can be used as a tool to mask compression artifacts
  - Which leads to increased subjective video quality

General framework

- General framework of the proposed contribution

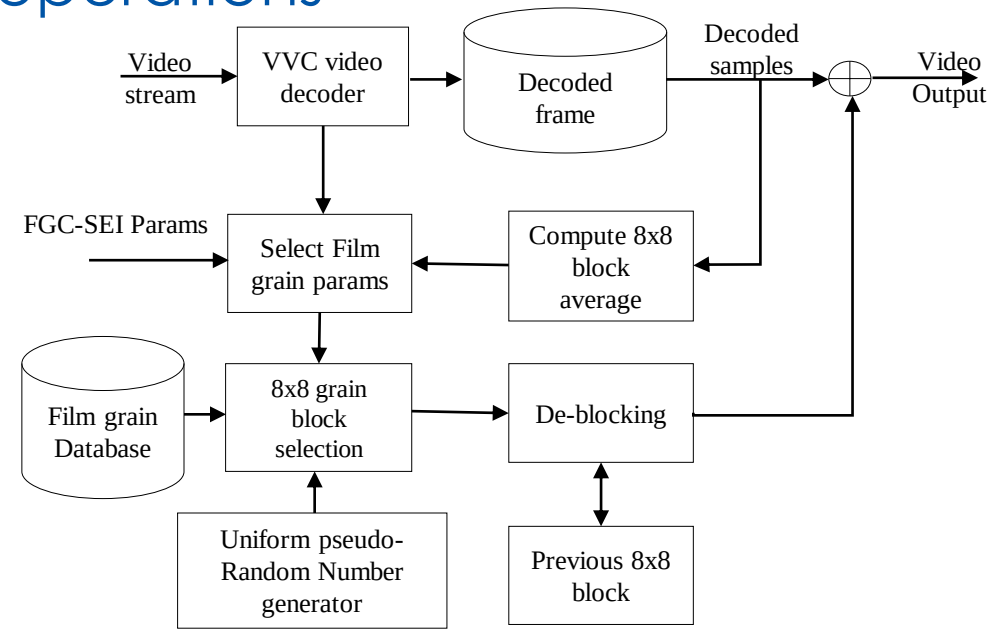


- Analysis and synthesis are not mandatory
- Complete framework is in conformance with standardized syntax
- The model we use is bit-exact, and complete framework is bit-exact
- To model film grain, this contribution uses
  - SMPTE RDD 5 specification (directly defines synthesis part)
  - Specification is based on frequency filtering model
  - Additive blending mode

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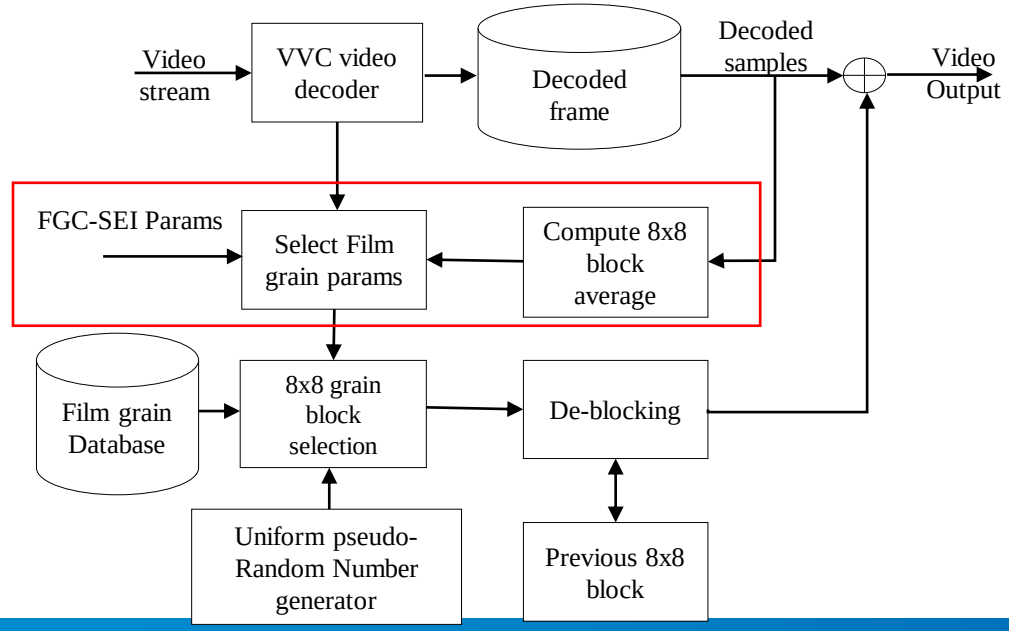
SMPTE RDD 5 Specification

- RDD 5 defines film grain synthesis part
- Database of film grain patterns
- Uniform pseudo-random number generator
- And complete and precise sequence of operations



SMPTE RDD 5 Specification

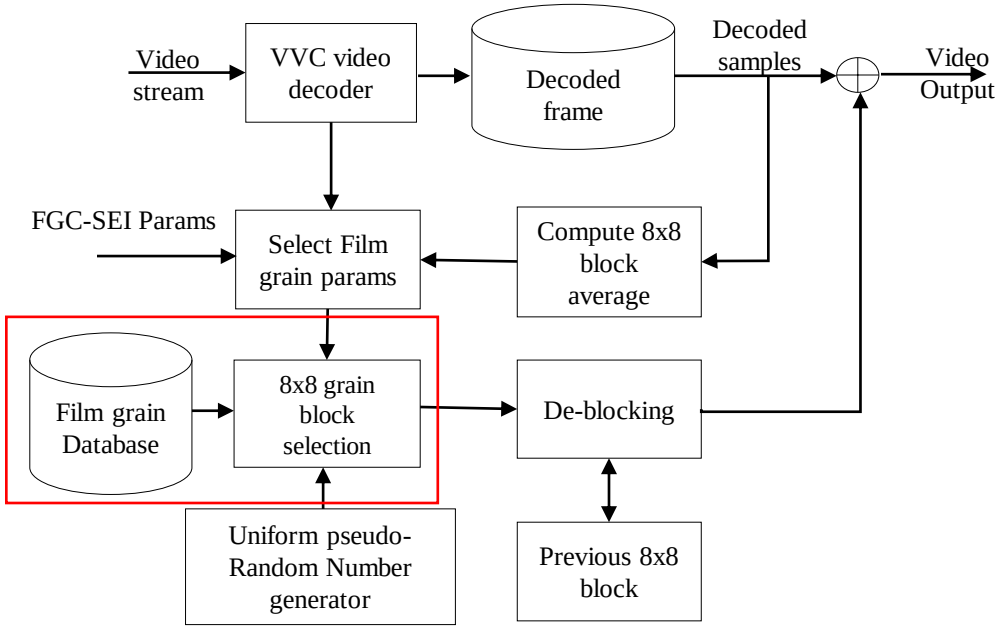
- Film grain is content dependent
- Hence RDD 5 model supports different intensity intervals for FG
  - Different film grain parameters for different intensity
  - Parameters are accessed based on block average
  - Parameters are used to access film grain database (if database is created off-line) or to create film grain patterns (on-fly)



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SMPTE RDD 5 Specification

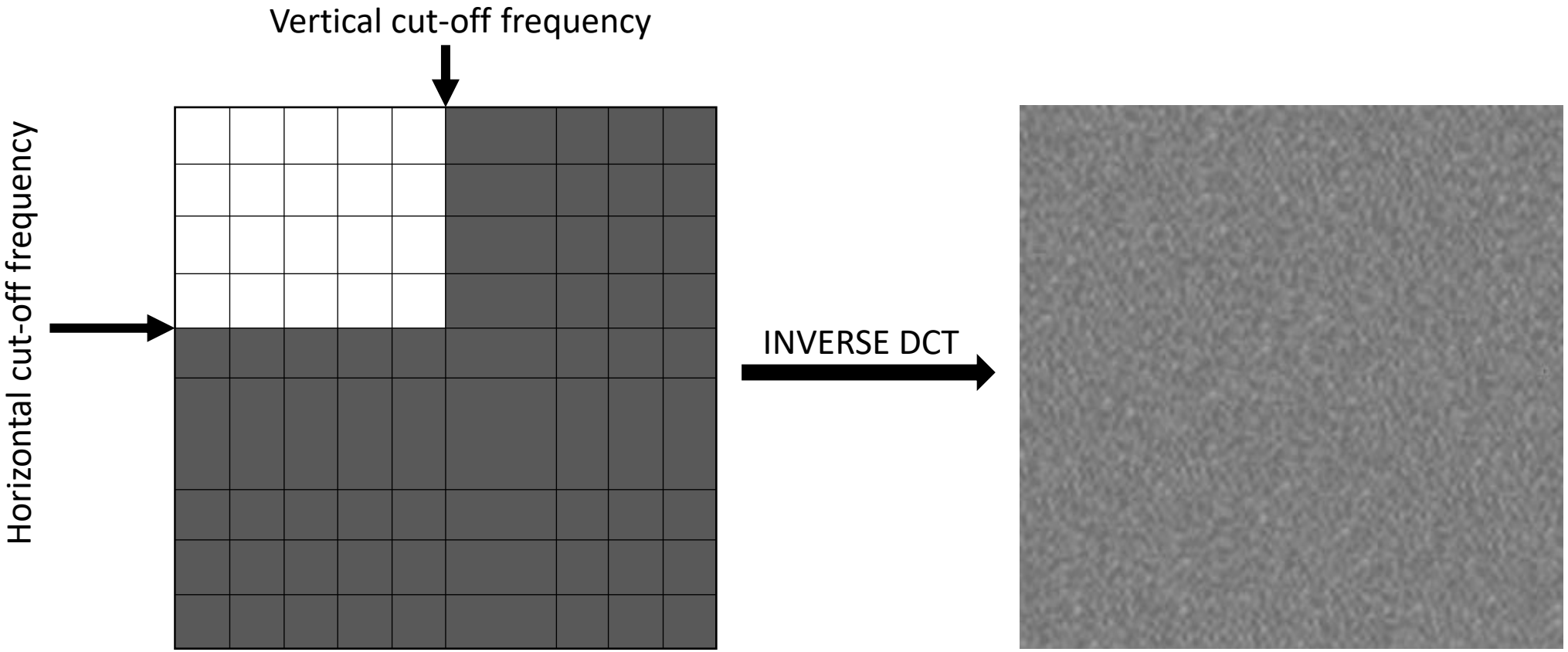
- To create film grain pattern (film grain database), start from predefined transformed block of Gaussian random numbers
  - Predefined in RDD 5
  - Already in transformed domain
  - RDD 5 uses internal DCT transform
  - Block size 64x64



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SMPTE RDD 5 Specification

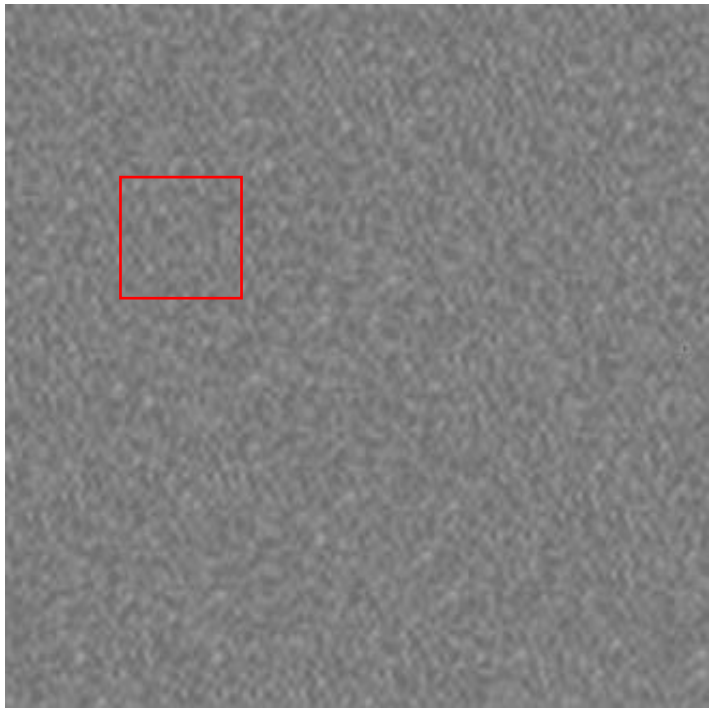
- Based on model parameters – Vertical and horizontal cut-off frequency
- VVC's DCT-2 64x64 can be used instead of RDD 5 internal transform



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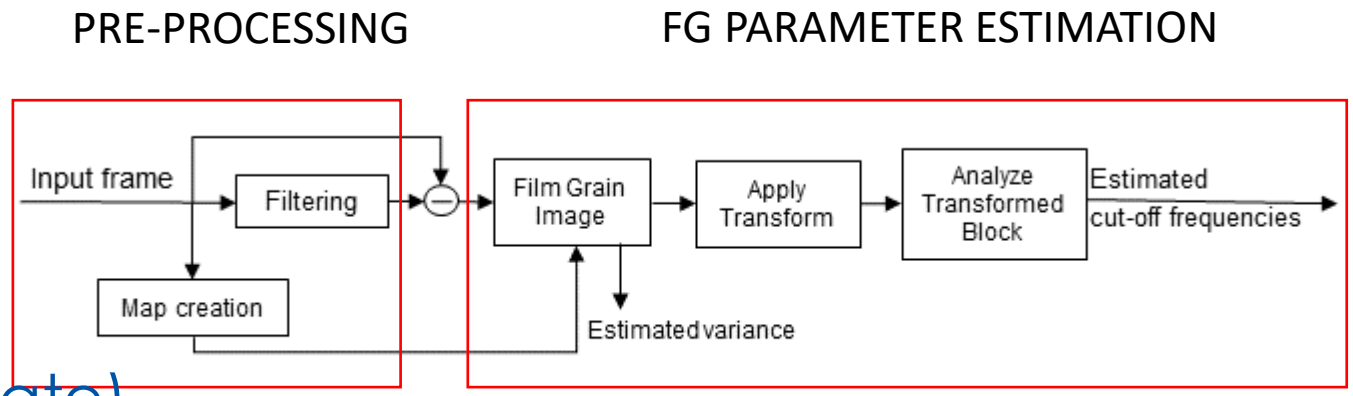
SMPTE RDD 5 Specification

- From 64x64 pseudo-randomly select 8x8 block (blending is done on 8x8 block)
- Scale it based on parameter from FGC SEI
- Blend it to frame
  - Additive blending
- SMPTE RDD 5 defines more precisely all steps



Film Grain Analysis

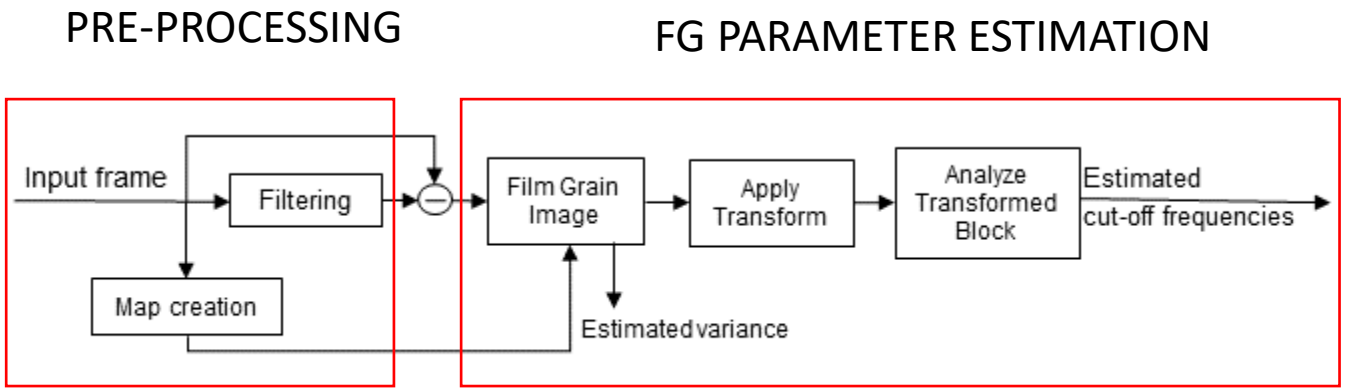
- To create map that indicates flat regions of an input frame
  - We use Canny edge detector on two scales, in combination with morphological operations
- For filtering we use MCTF
  - We created additional instance of EncTemporalFilter class
  - Encoding process is unchanged – we use internal picture buffer for FG filtering
  - For LD only on first frame
  - AI on all frames
  - RA per I period
  - Strength of filter is set to 1.5
- Filtered frame is used to find film grain image (film grain estimate)



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Film Grain Analysis

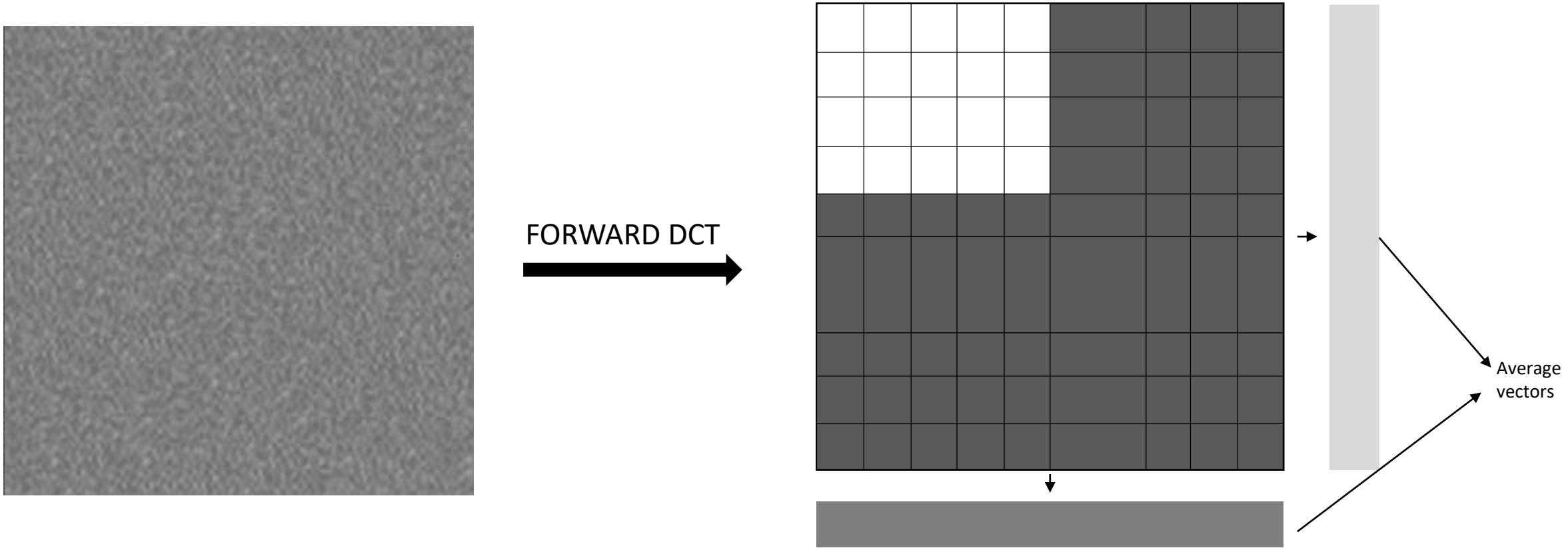
- Variance is used as scaling factor for film grain block before blending
- Found over all available 64x64 blocks
  - Blocks that belong to the flat regions of an input frame



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Film Grain Analysis

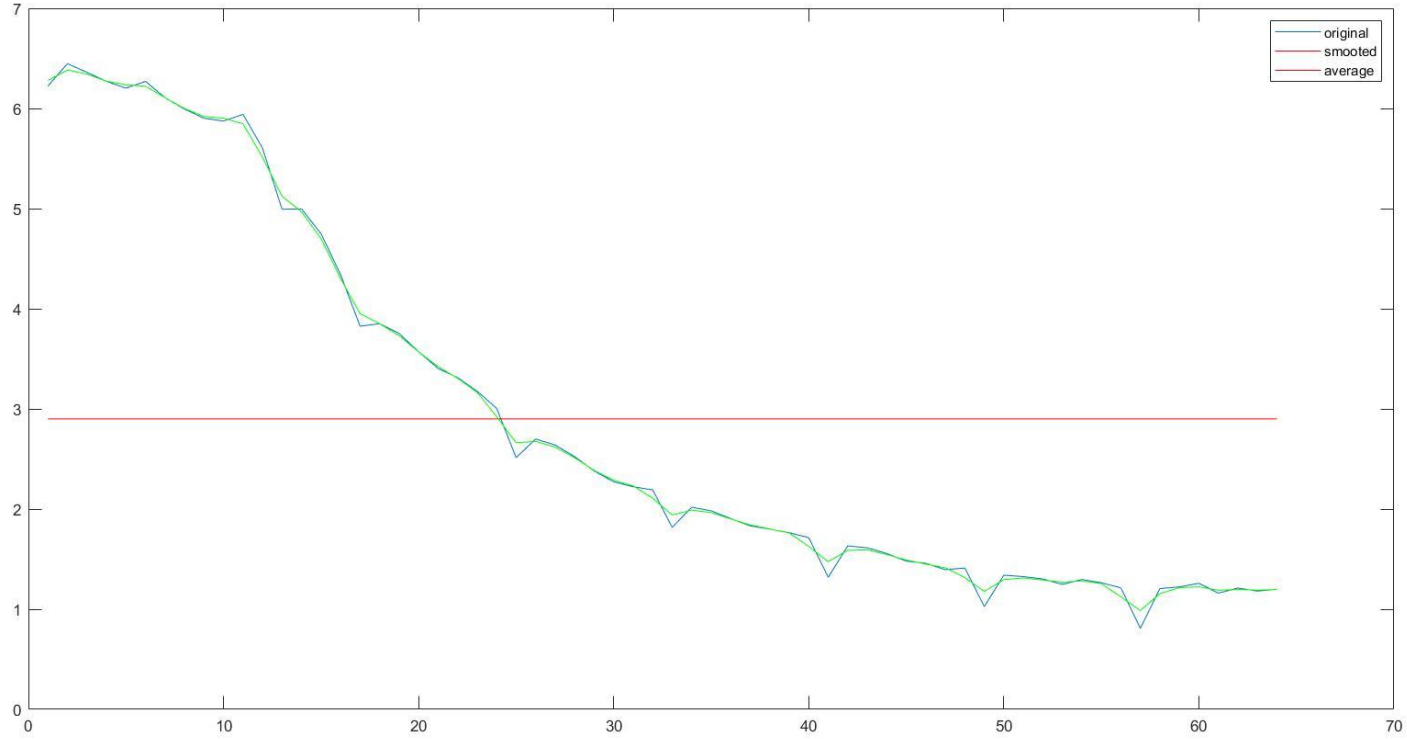
- For cut-off frequencies, we need to go in transform domain
- We use VVC's DCT-2 64x64
  - Which replaces RDD 5 transform



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Film Grain Analysis

- Index of the intersection point is estimated cut-off frequency
- For the current RDD 5 spec
  - cut-off frequency is scaled down to fit range of the parameter defined in the spec



Software

- For both synthesis and analysis part
- Code is initial version and there is space for improvement
  - We would appreciate comments from the community
- Code will be provided

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Original



Reconstructed+FG, Qp=37



Reconstructed, Qp=37

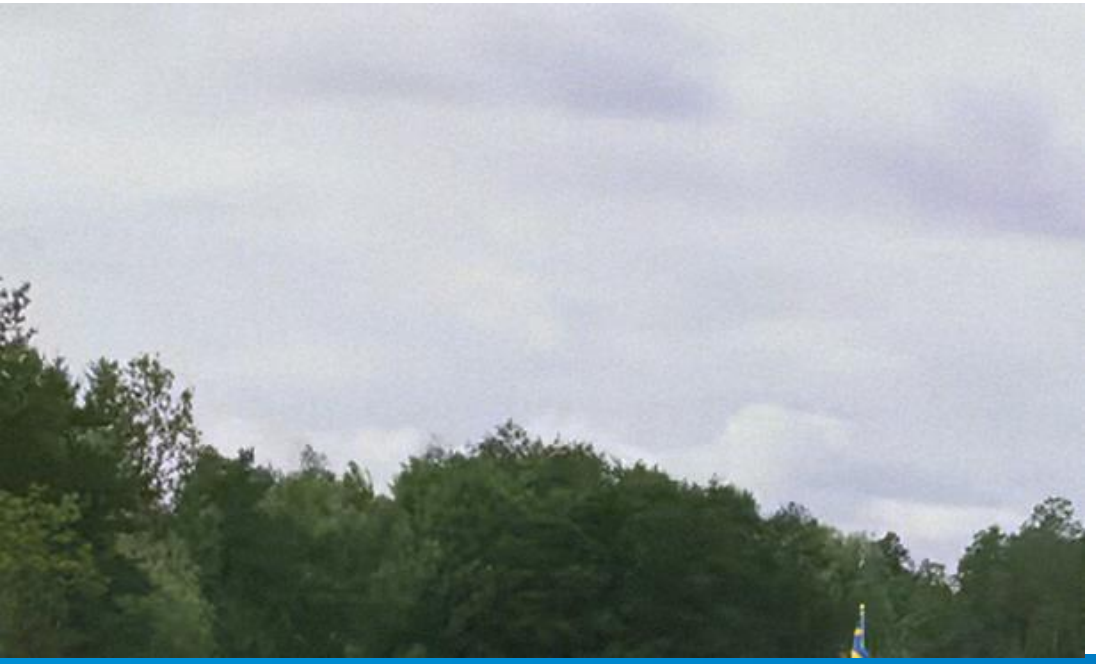




Original

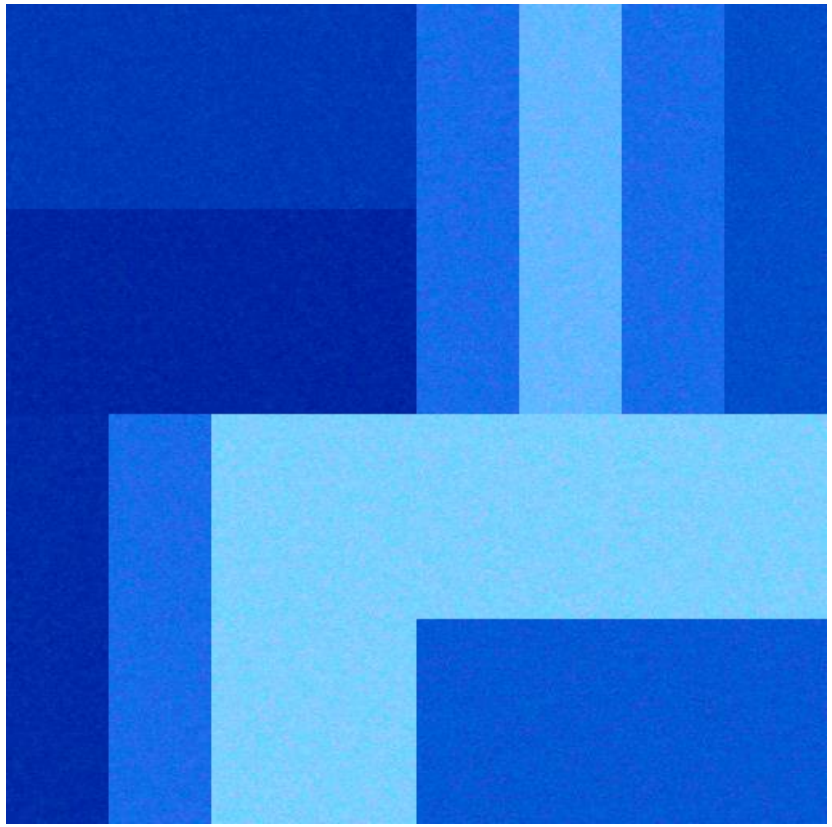


Decoded

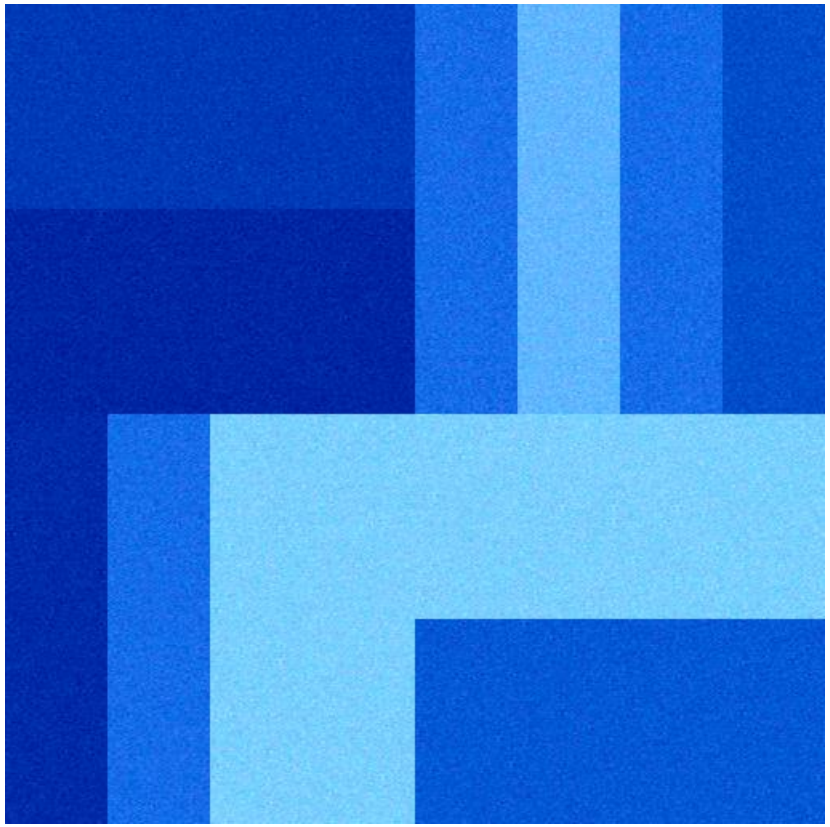


Decoded+FG

Results



Original



Reconstructed+FG, Qp 37



Reconstructed, Qp 37

Conclusions

- Film grain is good candidate to be considered for future use in VVC and VTM reference software.
  - It is reported that the visual quality benefits from the synthesized film grain
    - tool for subjective quality enhancement of compressed video
  - It may be relevant to make the FG synthesis and blending process more precisely specified, in order to guaranty reproducibility of the process
  - It may be relevant to make the FG synthesis and blending process mandatory, when the FG SEI is inserted in the bitstream
    - Mandatory post-processing
  - We propose to incorporate the software update in the VTM fork for future study

Acknowledgment

- Thanks to Dolby for cross-checking (JVET-V0151)
- We note that part of the code is based on previous Dolby's contribution
- This work has been achieved in the context of the 3EMS project funded by the "Region Bretagne"