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| *Title:* | **Illustration of the film grain characteristics SEI message in HEVC** | | |
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# Abstract

This contribution describes a software implementation that illustrates the use of the film grain characteristics SEI message in HEVC. Specifically, the software illustrates the example of film grain synthesis specified in SMPTE RDD 5 and signalling of film grain characteristics syntax values using the SEI message.

# Introduction

The film grain characteristics (FGC) SEI message in HEVC provides the decoder with a parameterized model for film grain synthesis. The syntax of the SEI message is shown in Table 1.

For example, an encoder may use the FGC SEI message to characterize film grain that was present in the original source video material and was removed by pre-processing filtering techniques. Synthesis of simulated film grain on the decoded images for the display process is optional and does not affect the decoding process specified in the HEVC specification.

As another example, an encoder may use the FGC SEI message to simulate film grain on the decoded images when film grain was not present in the original source video material.

The FGC SEI message enables signalling of different film grain simulation models, blending modes, bitdepths, transfer characteristics, and chroma processing options. In this contribution, we provide software for a particular use of the SEI message as a way of illustrating how it may be used and to provide a basis for experimentation. Specifically, the software illustrates the example of film grain synthesis in a manner consistent with SMPTE RDD 5 [1] and signalling of the corresponding model parameters values. The example software also illustrates the methods of SMPTE RDD 5 applied to 10- and 12-bit content in 4:2:2 and 4:4:4 chroma format and HDR transfer characteristics.

Table 1 Film grain characteristics SEI message syntax

|  |  |
| --- | --- |
| film\_grain\_characteristics( payloadSize ) { | **Descriptor** |
| **film\_grain\_characteristics\_cancel\_flag** | u(1) |
| if( !film\_grain\_characteristics\_cancel\_flag ) { |  |
| **film\_grain\_model\_id** | u(2) |
| **separate\_colour\_description\_present\_flag** | u(1) |
| if( separate\_colour\_description\_present\_flag ) { |  |
| **film\_grain\_bit\_depth\_luma\_minus8** | u(3) |
| **film\_grain\_bit\_depth\_chroma\_minus8** | u(3) |
| **film\_grain\_full\_range\_flag** | u(1) |
| **film\_grain\_colour\_primaries** | u(8) |
| **film\_grain\_transfer\_characteristics** | u(8) |
| **film\_grain\_matrix\_coeffs** | u(8) |
| } |  |
| **blending\_mode\_id** | u(2) |
| **log2\_scale\_factor** | u(4) |
| for( c = 0; c < 3; c++ ) |  |
| **comp\_model\_present\_flag**[ c ] | u(1) |
| for( c = 0; c < 3; c++ ) |  |
| if( comp\_model\_present\_flag[ c ] ) { |  |
| **num\_intensity\_intervals\_minus1**[ c ] | u(8) |
| **num\_model\_values\_minus1**[ c ] | u(3) |
| for( i = 0; i <= num\_intensity\_intervals\_minus1[ c ]; i++ ) { |  |
| **intensity\_interval\_lower\_bound**[ c ][ i ] | u(8) |
| **intensity\_interval\_upper\_bound**[ c ][ i ] | u(8) |
| for( j = 0; j <= num\_model\_values\_minus1[ c ]; j++ ) |  |
| **comp\_model\_value**[ c ][ i ][ j ] | se(v) |
| } |  |
| } |  |
| **film\_grain\_characteristics\_persistence\_flag** | u(1) |
| } |  |
| } |  |

# Illustration of FGC SEI message based on SMPTE RDD 5

The software provided is based on the latest version of HEVC reference software HM (SHA: 09edbed227b910ee59e4e2afd9bae6d996a271b7).

## Workflow

The film grain simulation and blending workflow for SMPTE RDD 5 is illustrated in Figure 1.SMPTE RDD 5 film grain simulation is accomplished by specifying: a database of film grain patterns; a uniform pseudo-random number generator; and a precise sequence of operations, all of which are specified in SMPTE RDD 5.

Figure 1 Film grain simulation and blending workflow for SMPTE RDD 5

Decoded samples

FGC-SEI Params

Video stream

HEVC video decoder

Decoded frame

Video Output

Select Film grain params

8x8 grain block selection

Film grain Database

Uniform pseudo-Random Number generator

De-blocking

Compute 8x8 block average

Previous 8x8 block

As specified in SMPTE RDD 5, the database of film grain patterns is composed of 169 patterns of 4,096 film grain samples, each representing a 64×64 film grain image.

## Syntax settings

For the SMPTE RDD 5 example, the parameters conveyed as part of the FGC SEI message are tabulated in Table *2*.

Table 2 FGC SEI syntax parameter values for SMPTE RDD 5

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Supported value / Range** | **Explanation** |
| film\_grain\_model\_id | 0 | Frequency filtering model |
| separate\_colour\_description\_present\_flag | 0 | Film grain colour space same as encoding colour space |
| blending\_mode\_id | 0 | Additive blending |
| log2\_scale\_factor | 2-7 | Ensures simulation compatible with 16-bit signed integer math |
| num\_model\_values\_minus1[ c ] | 0-2 | Bandpass and cross-colour correlation not supported |
| comp\_model\_value[ c ][ i ][ 0 ] | 0-(2Bitdepth – 1) | See Note |
| comp\_model\_value[ c ][ i ][ 1 ] | 2-14 | Indicates horizontal cut-off frequency |
| comp\_model\_value[ c ][ i ][ 2 ] | 2-14 | Indicates vertical cut-off frequency |
| film\_grain\_characteristics\_persistence\_flag | 0 | FGC SEI message applied to the current decoded frame only |

Note: SMPTE-RDD5 is specified for 8-bits but the example software implementation we provide extends RDD5 to higher bit depths, which allows comp\_model\_value[c][i][0] to exceed 255 for higher bit depths, with a maximum supported value of (2Bitdepth – 1).

## Software description

The FGS software in under Macro FGS\_RDD5\_ENABLE.

film\_grain\_characterstics.cfg is updated by adding new configuration parameters to be able to specify the parameters for each component: num\_intensity\_intervals\_minus1, num\_model\_values\_minus1, intensity\_interval\_lower\_bound, intensity\_interval\_higher\_bound and comp\_model\_value.

The encoding command line is:

TAppEncoder.exe –c encoder\_randomaccess\_main10.cfg –c input.cfg –c film\_grain\_characterstics.cfg

The decoding command line is:

TAppDecoder.exe –b str.bin –o decoded.yuv --SEIFGSFilename=decoded\_FGS.yuv

# Simulations

We tested various settings to verify the correctness of the software. For crosschecking purposes, we used one HEVC CTC clip ArenaOfValor 1080p 4:2:0 test sequence encoded with Main 10 profile. ArenaOfValor is a gaming sequence captured from screen so it is clean and easier to observe the effect of simulated film grain.

We have provided 5 settings. The first 4 settings simulate film grain only on the luma component. The fifth setting simulates film grain on both luma and chroma components. The first 3 settings are to test film grain sizes by modifying horizontal/vertical high-cut frequency. The values used are [2 2] [8 8] and [14 14]. The film grain size gets smaller as the high-cut frequency gets larger. The 4th setting is to test film grain with multiple intensity intervals. The fifth setting is to test FG on both luma and chroma.

In order to see the effect of film grain simulation clearly, we purposely selected a value of simulated film grain variance larger than would be sensible for real applications, except for the 4th setting. In the 4th setting, for QP37, it is observed that simulated film grain can hide blocky artefacts.

It was observed that the example software implementation and FGC SEI message function as expected.

# Acknowledgment

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# References

1. “RDD 5:2006 - SMPTE Registered Disclosure Doc - Film Grain Technology — Specifications for H.264 | MPEG-4 AVC Bitstreams,” RDD 5:2006, pp. 1–18, Mar. 2006, doi: 10.5594/SMPTE.RDD5.2006.

# Patent rights declaration(s)

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