

JVET-Q0424

Mandatory film grain



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Background



Substantial benefits from adding film grain after decoding has been demonstrated in the past

Film grain is supported by SEI messages in AVC, HEVC and VVC

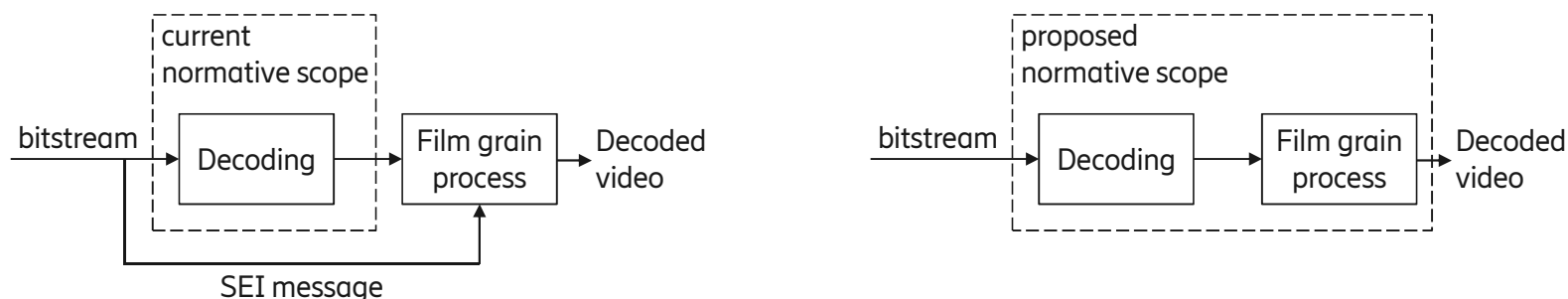
- The SEI carries a parametrized model for film grain synthesis in the decoder
- The SEI film grain processes are not fully specified (no conformance testing of the SEI message is possible)

Problems with the SEI method

- Basing the intended output video quality on an SEI message is problematic since decoders are not required to implement them
- This means that an encoder that considers using the film grain SEI message to improve the video quality risks the consumer being provided with a decoded video sequence without film grain resulting in bad experience

Therefore, encoders don't use the SEI

Proposal summary



The following is proposed

- To make film grain generation normative and inside conformance
- When enabled, film grain is applied to the decoded picture before output, specified in Annex C, similar to how picture cropping is handled
- Use film grain syntax, semantics and processes similar to the design used in AV1 since it is expected that many decoder implementations will support both AV1 and VVC (See also JVET-Q0533)

Motivation

- Film grain generation is a very powerful coding tool with substantial subjective benefits
- History has shown that the SEI method rendered film grain unusable, this proposal changes that

Proposal details



The following elements are proposed:

1. Add an `sps_film_grain_enabled_flag` and a `film_grain_seed_len_minus1` syntax element to the SPS
2. Add an APS type, `FILM_GRAIN_APS`, to hold film grain model syntax elements
3. Add a `pic_film_grain_present_flag`, a `pic_film_grain_aps_is` and a `film_grain_seed` syntax element to the picture header, where the length of the `film_grain_seed` syntax element is equal to `film_grain_seed_len_minus1+1`
4. Derive the seed to use as equal to $\text{slice_pic_order_cnt_lsb} \ll (\text{film_grain_seed_len_minus1} + 1) + \text{film_grain_seed}$
5. Reduce the maximum DPB size by 1 when `sps_film_grain_enabled_flag` is equal to 1
6. Add a film grain generation process in Annex C stating the film grain shall be applied when a picture is output if `sps_film_grain_enabled_flag` is equal to 1

Suggested SPS text



seq_parameter_set_rbsp() {	Descriptor
sps_sao_enabled_flag	u(1)
sps_alf_enabled_flag	u(1)
sps_film_grain_enable_flag	u(1)
if(sps_film_grain_enable_flag)	
film_grain_seed_len_minus1	u(4)
...	

sps_film_grain_enable_flag equal to 1 specifies that film grain may be applied to pictures in the CLVS.
sps_film_grain_enable_flag equal to 0 specifies that film grain shall not be applied to any picture in the CLVS.

film_grain_seed_len_minus1 plus 1 specifies the length, in bits, of the film_grain_seed syntax element.

Suggested APS text



adaptation_parameter_set_rbsp() {	Descriptor
adaptation_parameter_set_id	u(5)
aps_params_type	u(3)
if(aps_params_type == ALF_APS)	
alf_data()	
else if(aps_params_type == LMCS_APS)	
lmcs_data()	
else if(aps_params_type == SCALING_APS)	
scaling_list_data()	
else if(aps_params_type == FILM_GRAIN_APS)	
film_grain_data()	
...	u(1)

Table 6 – APS parameters type codes and types of APS parameters

aps_params_type	Name of aps_params_type	Type of APS parameters
0	ALF_APS	ALF parameters
1	LMCS_APS	LMCS parameters
2	SCALING_APS	Scaling list parameters
3	FILM_GRAIN_APS	Film grain parameters
34..7	Reserved	Reserved

7.4.3.5 Adaptation parameter set semantics

Each APS RBSP shall be available to the decoding process prior to it being referenced, included in at least one AU with TemporalId less than or equal to the TemporalId of the coded slice NAL unit that refers it or provided through external means.

All APS NAL units with a particular value of adaptation_parameter_set_id and a particular value of aps_params_type within a PU, regardless of whether they are prefix or suffix APS NAL units, shall have the same content.

adaptation_parameter_set_id provides an identifier for the APS for reference by other syntax elements.

When aps_params_type is equal to ALF_APS, **or** SCALING_APS, **or** FILM_GRAIN_APS, the value of adaptation_parameter_set_id shall be in the range of 0 to 7, inclusive.

When aps_params_type is equal to LMCS_APS, the value of adaptation_parameter_set_id shall be in the range of 0 to 3, inclusive.

aps_params_type specifies the type of APS parameters carried in the APS as specified in Table 6.

Suggested picture header text



picture_header_rbsp() {	Descriptor
...	
pic_scaling_list_aps_id	u(3)
}	
if(sps_film_grain_enable_flag) {	
pic_film_grain_present_flag	u(1)
if(pic_film_grain_present_flag) {	
pic_film_grain_aps_id	u(3)
film_grain_seed	u(v)
}	
}	
if(picture_header_extension_present_flag) {	
...	

pic_film_grain_present_flag equal to 1 specifies that the film grain generation process as specified in clause C.3.5 shall be invoked, with the decoded picture associated with this picture header as input, when the decoded picture is output. **pic_film_grain_present_flag** equal to 0 specifies that the film grain generation process shall not be invoked for the decoded picture. When not present, the value of **pic_film_grain_present_flag** is inferred to be equal to 0.

pic_film_grain_aps_id specifies the **adaptation_parameter_set_id** of the film grain APS. The TemporalId of the APS NAL unit having **aps_params_type** equal to **FILM_GRAIN_APS** and **adaptation_parameter_set_id** equal to **pic_film_grain_aps_id** shall be less than or equal to the TemporalId of the picture associated with PH.

film_grain_seed specifies the seed value to use for the picture to generate film grain. The length of the **film_grain_seed** syntax element is **film_grain_seed_len_minus1 + 1** bits.

Suggested slice header text



7.4.8.1 General slice header semantics

slice_pic_order_cnt_lsb specifies the picture order count modulo `MaxPicOrderCntLsb` for the current picture. The length of the `slice_pic_order_cnt_lsb` syntax element is `log2_max_pic_order_cnt_lsb_minus4 + 4` bits. The value of the `slice_pic_order_cnt_lsb` shall be in the range of 0 to `MaxPicOrderCntLsb - 1`, inclusive.

When the current picture is a GDR picture, the variable `RpPicOrderCntVal` is derived as follows:

$$\text{RpPicOrderCntVal} = \text{PicOrderCntVal} + \text{recovery_poc_cnt} \quad (114)$$

When `pic_film_grain_present_flag` is equal to 1, the parameter `FilmGrainSeed` is derived as follows:

$$\text{FilmGrainSeed} = \text{slice_pic_order_cnt_lsb} \ll (\text{film_grain_seed_len_minus1} + 1) + \text{film_grain_seed} \quad (\text{X})$$

Suggested slice header text



A.4.2 Profile-specific level limits

...

When the specified level is not level 8.5, the value of `max_dec_pic_buffering_minus1[Htid] + 1` shall be less than or equal to `MaxDpbSize`, which is derived as follows:

```
if( PicSizeInSamplesY <= ( MaxLumaPs >> 2 ) )
    MaxDpbSize = Min( 4 * maxDpbPicBuf, 16 - sps_film_grain_enable_flag )
else if( PicSizeInSamplesY <= ( MaxLumaPs >> 1 ) )
    MaxDpbSize = Min( 2 * maxDpbPicBuf, 16 - sps_film_grain_enable_flag )
else if( PicSizeInSamplesY <= ( ( 3 * MaxLumaPs ) >> 2 ) )
    MaxDpbSize = Min( ( 4 * maxDpbPicBuf ) / 3, 16 - sps_film_grain_enable_flag )
else
    MaxDpbSize = maxDpbPicBuf - sps_film_grain_enable_flag
```

(A.1)

where `MaxLumaPs` is specified in Table A.1, and `maxDpbPicBuf` is equal to 8.

Suggested picture output text



C.3.3 Picture output

The output of the current picture is specified as follows:

- If PictureOutputFlag is equal to 1 and DpbOutputTime[n] is equal to CpbRemovalTime[n], the current picture is output.
- Otherwise, if PictureOutputFlag is equal to 0, the current picture is not output, but will be stored in the DPB as specified in clause C.3.4.
- Otherwise (PictureOutputFlag is equal to 1 and DpbOutputTime[n] is greater than CpbRemovalTime[n]), the current picture is output later and will be stored in the DPB (as specified in clause C.3.4) and is output at time DpbOutputTime[n] unless indicated not to be output by NoOutputOfPriorPicsFlag equal to 1.

When output, the picture is cropped, using the conformance cropping window for the picture. If pic_film_grain_present_flag is equal to 1, film grain is applied to the picture as specified in clause C.3.5.

When picture n is a picture that is output and is not the last picture of the bitstream that is output, the value of the variable DpbOutputInterval[n] is derived as follows:

$$\text{DpbOutputInterval}[n] = \text{DpbOutputTime}[\text{nextPicInOutputOrder}] - \text{DpbOutputTime}[n] \quad (\text{C.16})$$

where nextPicInOutputOrder is the picture that follows picture n in output order and has PictureOutputFlag equal to 1.

...

Suggested film grain process text



C.3.5 Film grain generation process

This process is applied to a picture before cropping and output.

Inputs to this process is the reconstructed picture after any in-loop filter process, i.e., the array `recPictureL` and, when `ChromaArrayType` is not equal to 0, the arrays `recPictureCb` and `recPictureCr`.

Outputs of this process is the output picture with film grain applied, i.e., the array `outPictureL` and, when `ChromaArrayType` is not equal to 0, the arrays `outPictureCb` and `outPictureCr`.

[Ed note: Add process here]

