JCTVC-AJ0029: AHG7: indication of shutter angle for variable frame rate application

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Dolby Laboratories, Inc.

Summary of proposal

Add **shutter angle information SEI message** in HEVC and AVC

Purpose:

- to indicate that shutter angle values are the same or different for different temporal sub-layers; and

- to signal one shutter angle value if all sub-layers have the same shutter angle, or signal one shutter angle value for each temporal sub-layer.
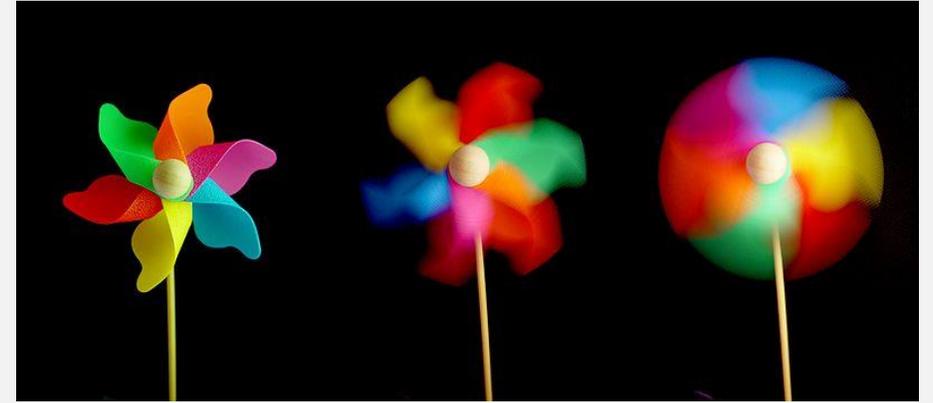
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Shutter angle is a term of art that indicates the effective exposure duration relative to frame duration and is thus also an indicator of motion blur

Shutter angle information can be particularly useful when different temporal sub-layers have different effective shutter angles and thus motion blur.

shutter angle information can be used to adjust the look of video on a display

Shutter angle

shutter_angle = frame_rate * 360/shutter_speed

shutter_speed is the inverse of exposure duration

frame_rate is the inverse of frame duration
(signalling of frame rate is supported in VUI)

Rotating disc shutter

The use of degrees to measure relative exposure time
is a hold over from the days when
movie cameras used rotating disk shutters

Shutter angle

$$\text{shutter\_angle} = \text{frame\_rate} * 360/\text{shutter\_speed}$$

shutter_speed is the inverse of exposure duration

frame_rate is the inverse of frame duration

(signalling of frame rate is supported in VUI)

Shutter angle, sharpness, and motion smoothness

Shutter angle affects the look of displayed video

Small shutter angle → sharper, more stutter

Large shutter angle → more motion blur, smoother
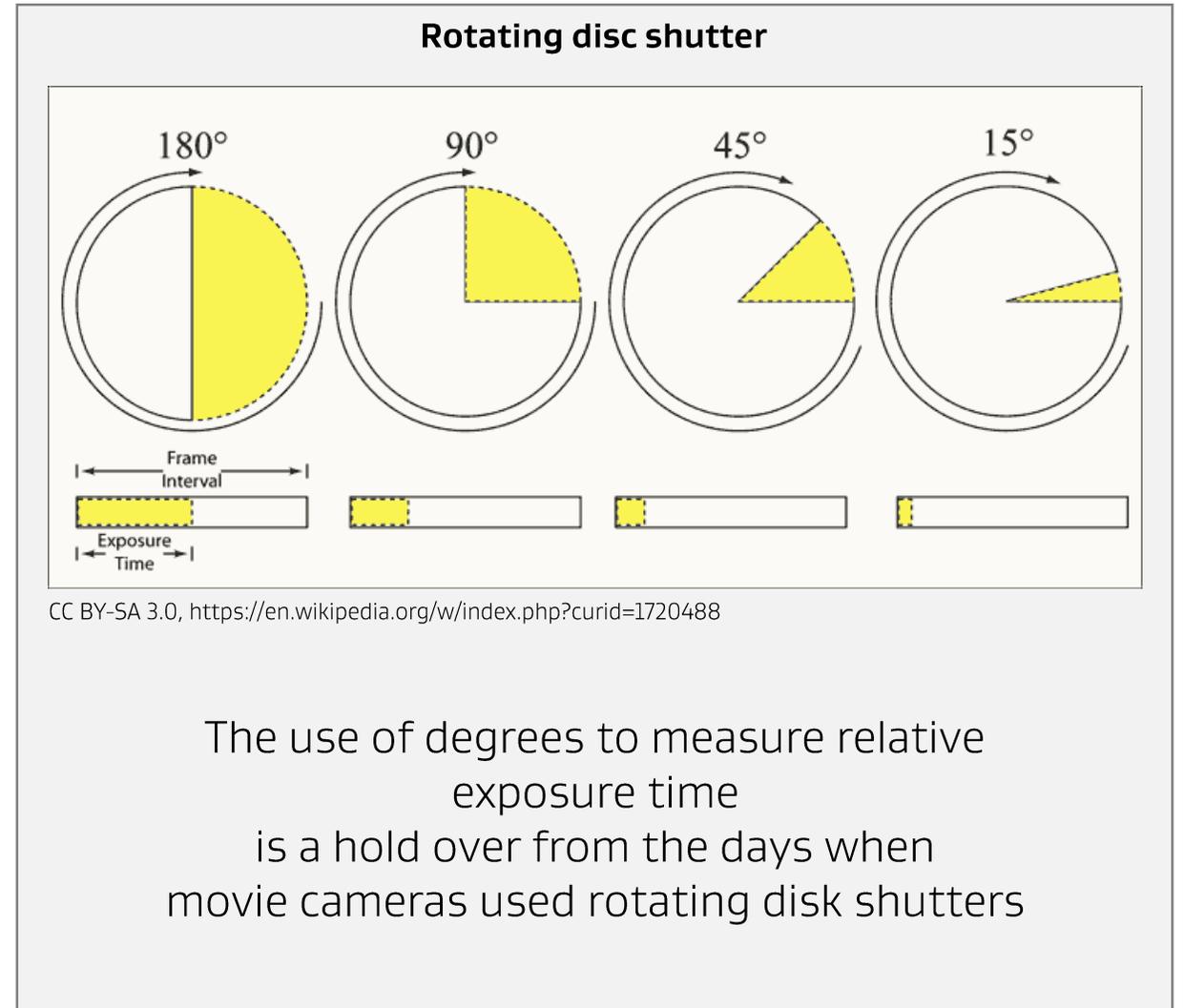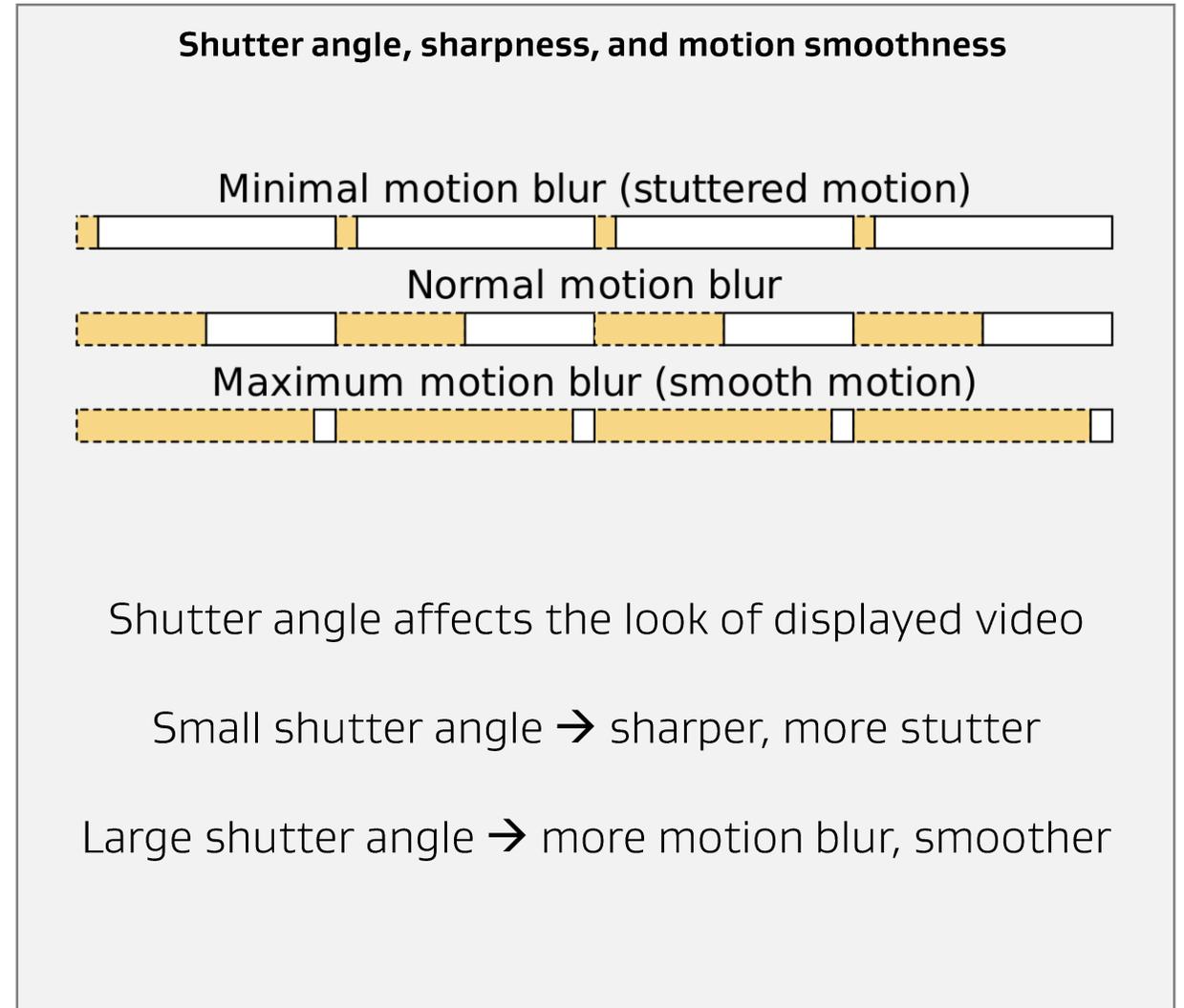
Shutter angle and temporal sub-layers

120 fps @ 360° shutter angle

Extracted sub-layers

60 fps @ 180° shutter angle
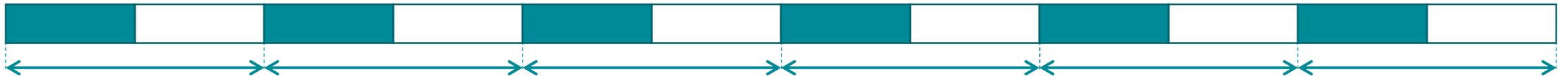
40 fps @ 120° shutter angle
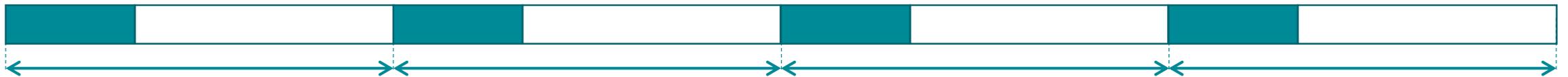
30 fps @ 90° shutter angle

Example: using shutter angle info to adjust displayed look
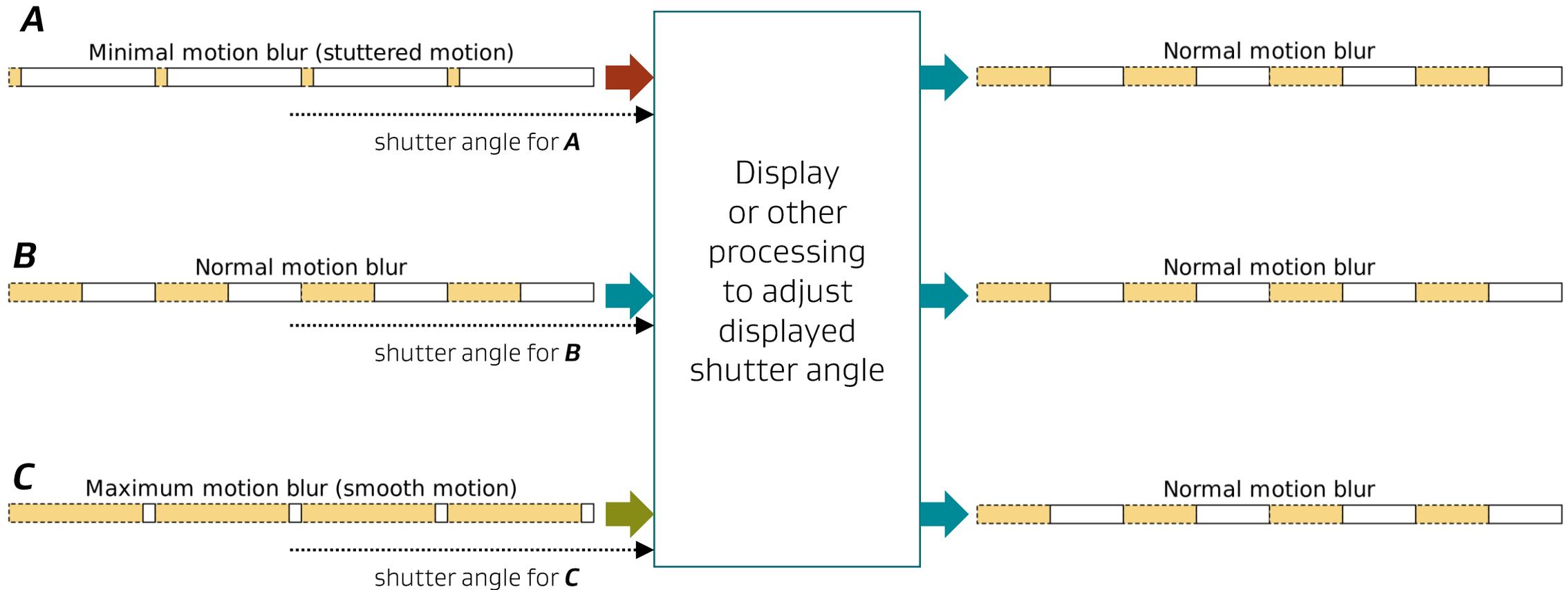
Proposal – HEVC

D.2.1 General SEI message syntax

sei_payload(payloadType, payloadSize) {	Descript or
if(nal_unit_type == PREFIX_SEI_NUT)	
if(payloadType == 0)	
buffering_period(payloadSize)	
[…]	
else if(payloadType == 153)	
shutter_angle_info(payloadSize)	
[…]	
}	
}	

D.2.41.3 Shutter angle information SEI message syntax

shutter_angle_info (payloadSize) { ( ) {	Descriptor
fixed_shutter_angle_within_cvs_flag	u(1)
if (fixed_shutter_angle_within_cvs_flag)	
fixed_shutter_angle	u(9)
else {	
for(i = 0; i <= sps_max_sub_layers_minus1; i++) {	
sub_layer_shutter_angle[i]	u(9)
}	
}	

D.3.41.3 Shutter angle information SEI message semantics

This SEI message indicates the shutter angle value associated with each temporal sub-layer for a progressive scanned CVS (field_seq_flag equal to 0). Shutter angle is a term of art that indicates shutter speed relative to frame rate, which is equivalent to indicating exposure duration relative to frame duration, used while authoring the video content.

This SEI message does not specify the measurement methodologies and procedures used for determining shutter angle values nor any description of the authoring conditions.

NOTE 1 – Shutter angle is expressed in degrees from 0 to 360 degrees. A shutter angle of 180 degrees, for example, indicates that the exposure duration is ½ the frame duration. The use of degrees to measure relative exposure time began when movie cameras used mechanical rotating disk shutters.

NOTE 2 – Shutter angle may be expressed as: shutter_angle = frame_rate * 360/shutter_speed, where shutter_speed is the inverse of exposure duration and frame_rate is the inverse of frame duration. frame_rate for the given temporal sub-layer Tid may be indicated by the **vui_num_units_in_tick**, **vui_time_scale** , **elemental_duration_in_tc_minus1**[Tid]. For example, when fixed_pic_rate_within_cvs_flag[Tid] is equal to 1, the frame rate for temporal sub-layer Tid may be indicated by frame_rate = vui_time_scale / (vui_num_units_in_tick * (elemental_duration_in_tc_minus1[Tid] + 1)) .

fixed_shutter_angle_within_cvs_flag equal to 1 specifies that shutter angle value is the same for all temporal sub-layers in the CVS. fixed_shutter_angle_within_cvs_flag equal to 0 specifies that shutter angle value may not be the same for all temporal sub-layers in the CVS.

fixed_shutter_angle specifies the shutter angle value in degrees. The value of fixed_shutter_angle shall be in the range of 0 to 360.

sub_layer_shutter_angle[i] specifies the shutter angle value in degrees when HighestTid is equal to i. The value of sub_layer_shutter_angle[i] shall be in the range of 0 to 360.

Proposal – AVC

D.1.1 General SEI message syntax

sei_payload(payloadType, payloadSize) {	C	Descriptor
[...]		
else if(payloadType == 153)		
Shutter_angle_info(payloadSize)	5	
[...]		
}		

D.1.35.3 Shutter angle information SEI message syntax

shutter_angle_info (payloadSize) { ( ) {	Descriptor
fixed_shutter_angle_within_cvs_flag	u(1)
if (fixed_shutter_angle_within_cvs_flag)	
fixed_shutter_angle	u(9)
else {	
for(i = 0; i <= num_layers_minus1; i++) {	
sub_layer_shutter_angle[i]	u(9)
}	
}	

D.2.35.3 Shutter angle information SEI message semantics

This SEI message indicates the shutter angle value associated with each temporal sub-layer for a progressive scanned coded video sequence (field_pic_flag equal to 0). Shutter angle is a term of art that indicates shutter speed relative to frame rate, which is equivalent to indicating exposure duration relative to frame duration, used while authoring the video content.

This SEI message does not specify the measurement methodologies and procedures used for determining shutter angle values nor any description of the authoring conditions.

> NOTE 1 – Shutter angle is expressed in degrees from 0 to 360 degrees. A shutter angle of 180 degrees, for example, indicates that the exposure duration is ½ the frame duration. The use of degrees to measure relative exposure time began when movie cameras used mechanical rotating disk shutters.

> NOTE 2 – Shutter angle may be expressed as: shutter_angle = frame_rate * 360/shutter_speed, where shutter_speed is the inverse of exposure duration and frame_rate is the inverse of frame duration. frame_rate for the given temporal sub-layer Tid may be indicated by the **vui_ext_num_units_in_tick**[Tid] and **vui_ext_time_scale**[Tid]. For example, when vui_ext_fixed_frame_rate_flag[Tid] is equal to 1, the frame rate for temporal sub-layer Tid may be indicated by frame_rate = vui_ext_time_scale[Tid] / vui_ext_num_units_in_tick[Tid] .

fixed_shutter_angle_within_cvs_flag equal to 1 specifies that shutter angle value is the same for all temporal sub-layers in the coded video sequence. fixed_shutter_angle_within_cvs_flag equal to 0 specifies that shutter angle value may not be the same for all temporal sub-layers in the coded video sequence.

fixed_shutter_angle specifies the shutter angle value in degrees. The value of fixed_shutter_angle shall be in the range of 0 to 360.

sub_layer_shutter_angle[i] specifies the shutter angle value in degrees when HighestTid is equal to i. The value of sub_layer_shutter_angle[i] shall be in the range of 0 to 360.

Conclusion

- Proposal provides support for signalling shutter angle information using an SEI message

- Shutter angle information can be particularly useful when different temporal sub-layers have different effective shutter angles

- Shutter angle information may be used by display or other post-decode processes to achieve a consistent or other desired look for bitstreams extracted at different frame rates

- Recommendation: adopt shutter angle information SEI message for HEVC and AVC