



JVET-00436: AHG8/AHG17: indication of shutter angle for variable frame rate application

July, 2019

Dolby Laboratories, Inc.

Summary of proposal

Add **shutter angle information SEI message** in VVC

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.

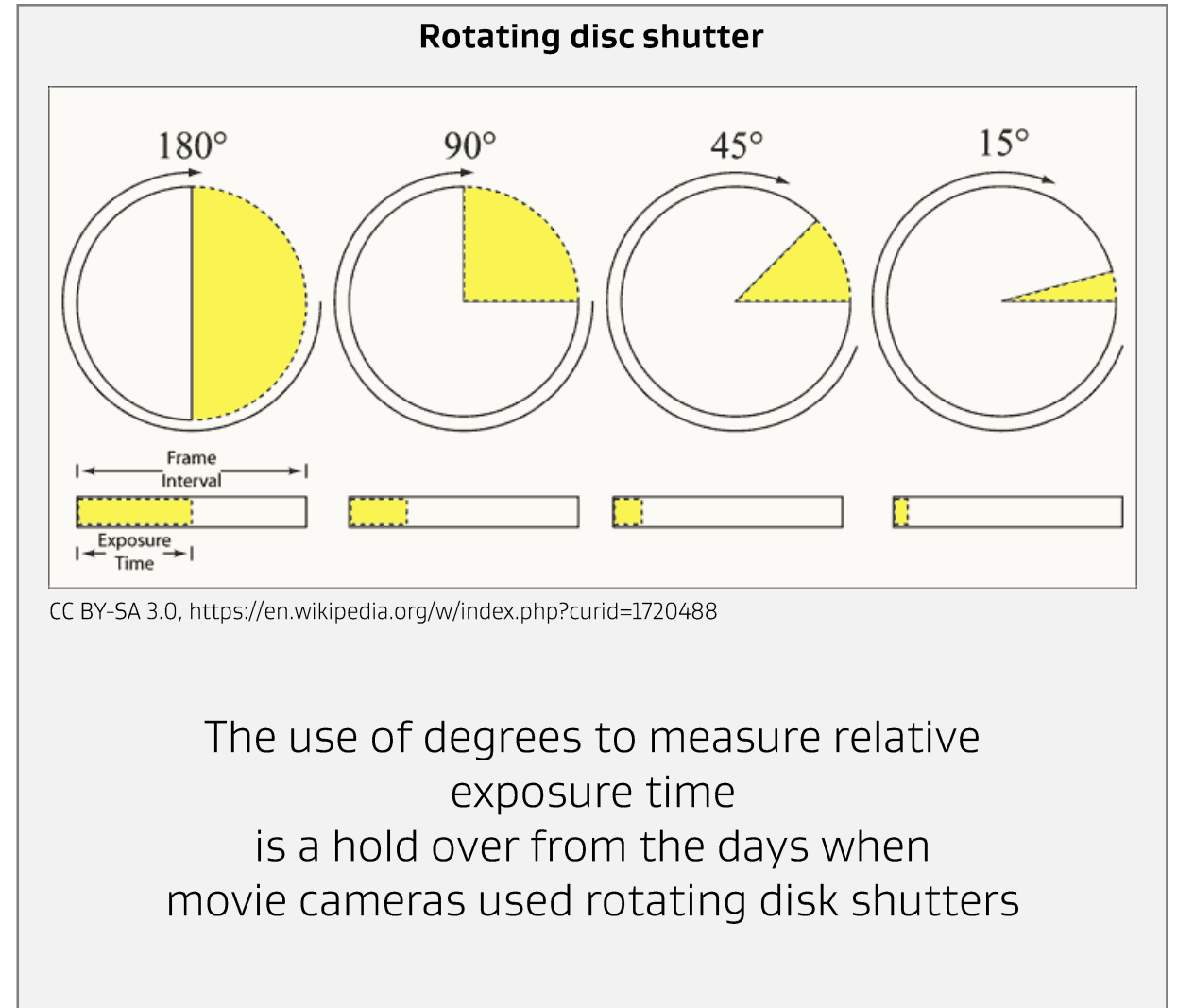
shutter angle information can be used to adjust the look of video on a display

Shutter angle

$\text{shutter_angle} = \text{frame_rate} * 360 / \text{shutter_speed}$

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

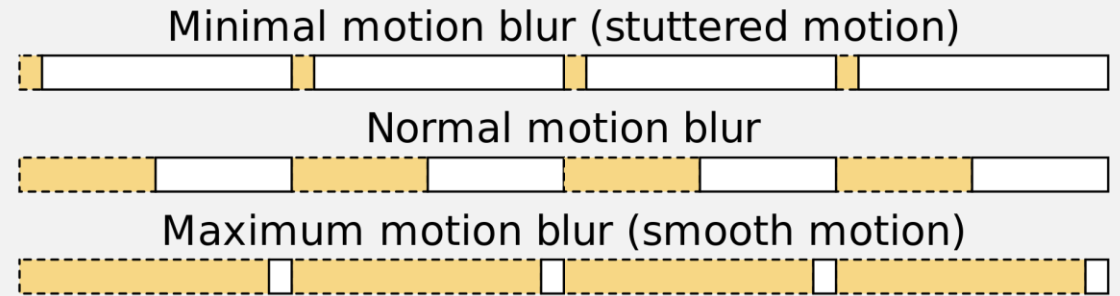
$\text{shutter_angle} = \text{frame_rate} * 360 / \text{shutter_speed}$

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

Image by en:User:Cburnett - Own work. This W3C-unspecified vector image was created with Inkscape., CC BY-SA 3.0, <https://commons.wikimedia.org/w/index.php?curid=1499295>

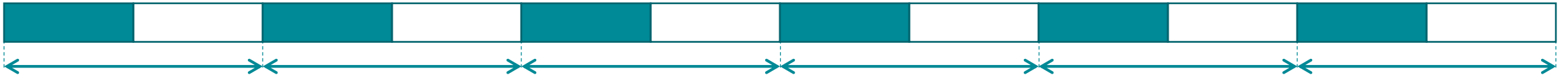
Shutter angle and temporal sub-layers

120 fps @ 360° shutter angle



Extracted sub-layers

60 fps @ 180° shutter angle



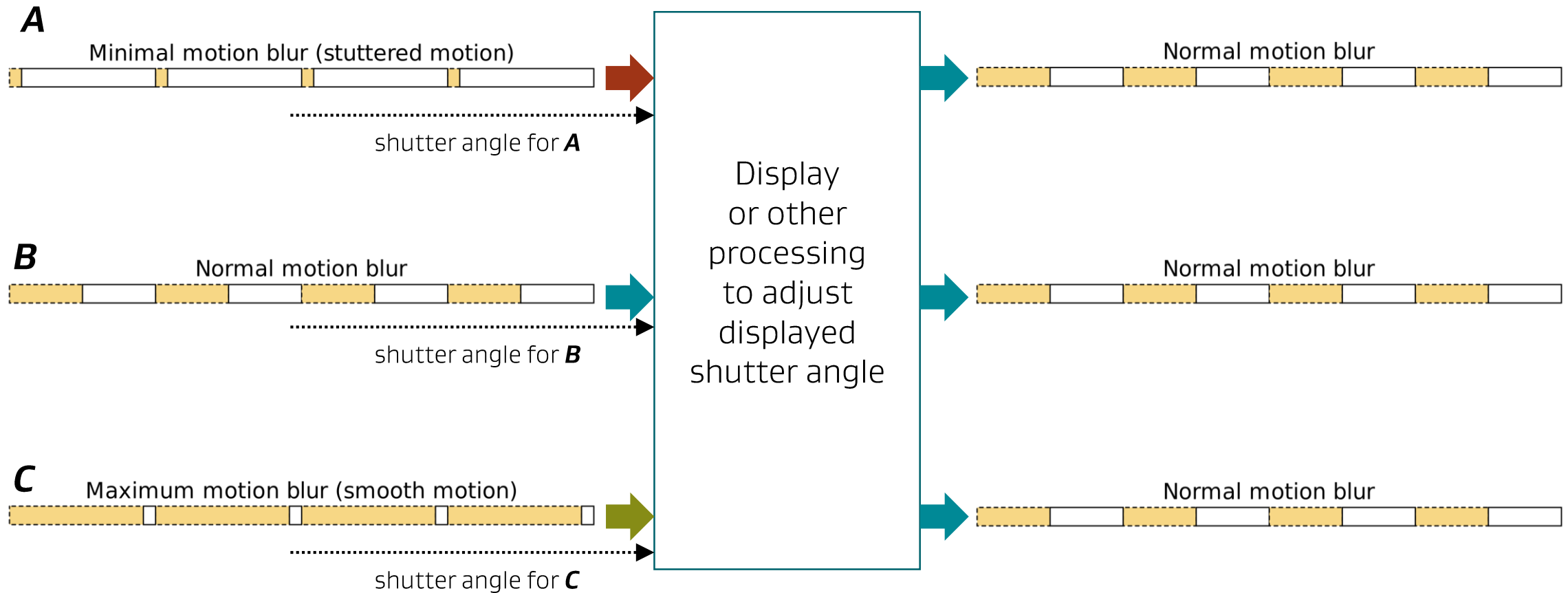
40 fps @ 120° shutter angle



30 fps @ 90° shutter angle



Example: using shutter angle info to adjust displayed look



Proposal

Shutter angle information SEI message syntax

shutter_angle_information (payloadSize) { () {	Descriptor
fixed_shutter_angle_flag_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)
}	
}	

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 $\frac{1}{2}$ 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: $\text{shutter_angle} = \text{frame_rate} * 360 / \text{shutter_speed}$, 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 **num_units_in_tick**, **time_scale**, **elemental_duration_in_tc_minus1**[Tid]. For example, when fixed_pic_rate_within_cvs_flag[Tid] is equal to 1: $\text{frame_rate} = \text{time_scale} / (\text{num_units_in_tick} * (\text{elemental_duration_in_tc_minus1}[\text{Tid}] + 1))$.

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.

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 VVC



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