

JVET-AH0138 AHG9/AHG16: Pupil position SEI message for Generative Face Video

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Introduction

- ❑ At the 33rd JVET meeting, the AHG on generative face video compression (GFVC) was established, among the mandates, one is to coordinate with AHG9 on further development of the GFVC SEI message in JVET-AG2032.
- ❑ In current generative face video coding architectures, facial information is often represented through: keypoints, landmarks, facial semantics or compact temporal features. Such representations cannot accurately represent eye movements.
- ❑ In addition, in JVET-AG2032 only an Eye matrix is used to represent the open-close status and level of eyes, which do not convey the changes of pupil position information.
- ❑ In this contribution, we propose to convey the concept of eye movement information and propose to add the GFV SEI message corresponding to the pupil center position.



Introduction

- ❑ Base picture: VVC-encoded
- ❑ Subsequent pictures: Facial representation extraction and arithmetic coding
- ❑ Reconstruction: Based on generative model

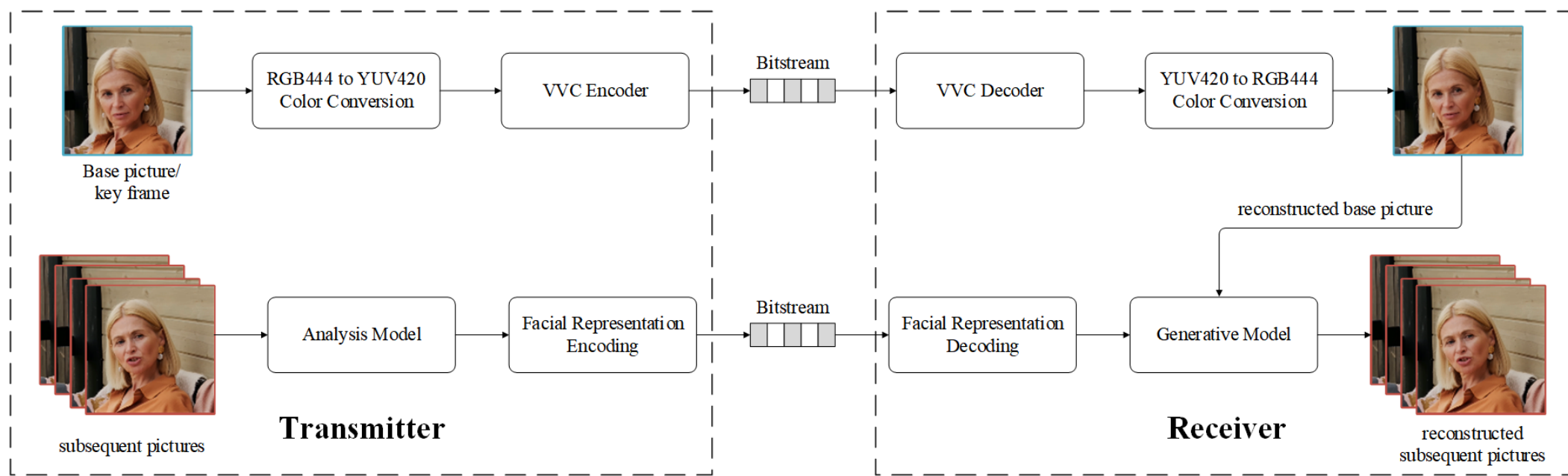


Figure 1 - General block diagram of GFVC

Problem statement

- We show in Figure 2 below, the difficulties of the generative model to generate accurate eye positions, highlighting the importance of **transmitting such information as part of the SEI information**

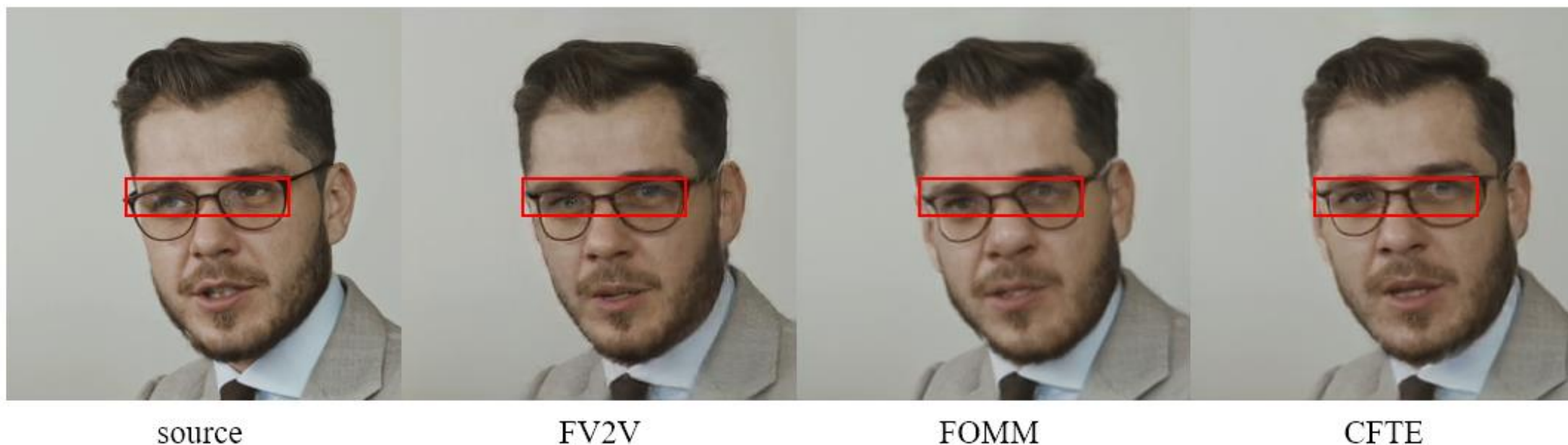


Figure 2 - Incorrect pupil position in current method

Proposed solution: Pupil position representation

- In this proposal, we propose to use relative coordinate information of the pupil position with respect to the inner eye corner of the eye, taken as the reference point.

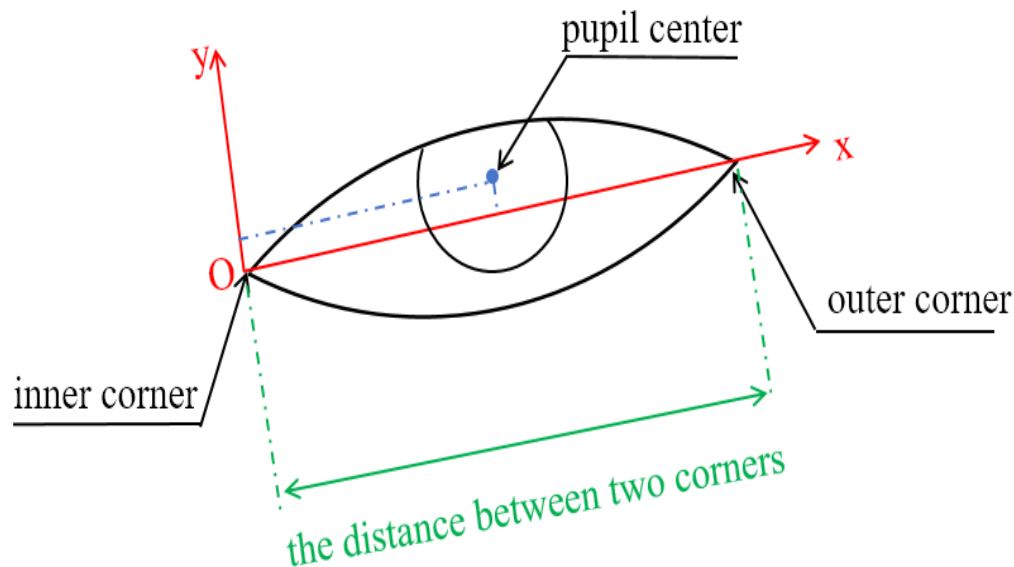


Figure 3 - Coordinate system of pupil center position with respect to the corner of the eye

- The pupil center coordinates (x, y) , correspond to the distance between the pupil center and the x-axis and y-axis, respectively
- X-axis and y-axis are normalized by the distance between the two corners of the eye
- Left, right or both pupil center position(s) can be transmitted using this representation
- Direct coordinate values (x, y) or predicted value with respect to the pupil center position in the base picture (dx, dy)

Proposed solution: GFV SEI information changes

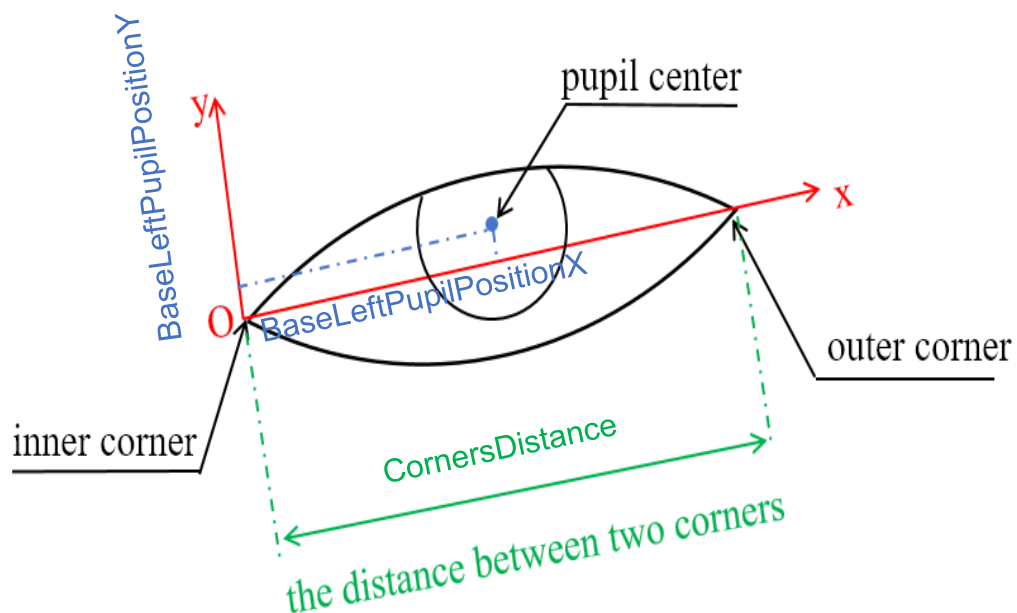


Figure 3 - Coordinate system of pupil center position with respect to the corner of the eye

Use of the SEI message requires the definition of the following variables:

- Distance between the corners denoted herein by **CornersDistance**.
- The pupil center position in the base picture, denoted as:

BaseLeftPupilPositionX,
BaseLeftPupilPositionY,
BaseRightPupilPositionX
and BaseRightPupilPositionY.

Proposed solution: GFV SEI information changes

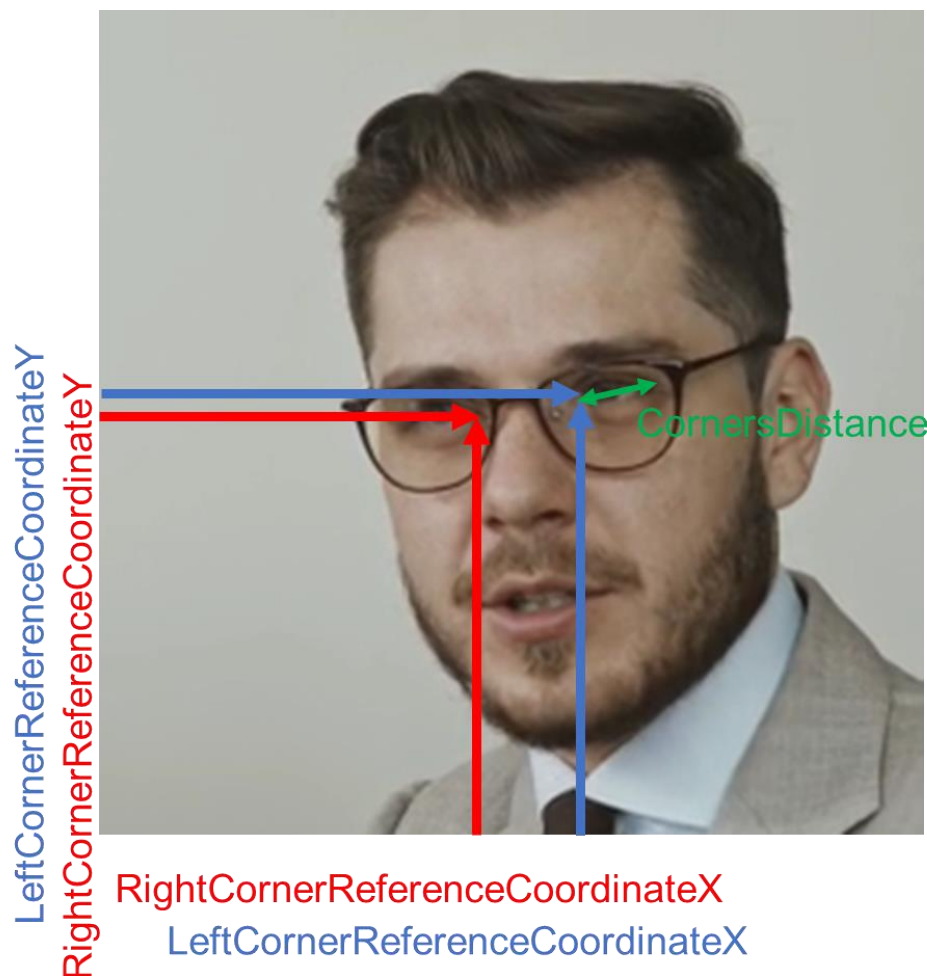


Figure 4 – Visual illustration of defined variables for inner eye corners

Use of the SEI message requires the definition of the following variables:

- The inner eye corner of the eye, as the reference point, denoted as:

LeftCornerReferenceCoordinateX,
LeftCornerReferenceCoordinateY,
RightCornerReferenceCoordinateX
and RightCornerReferenceCoordinateY.

Proposed solution: GFV SEI information changes

generative_face_video (payloadSize) {	Descriptor
gfv_id	ue(v)
gfv_cnt	ue(v)
gfv_base_pic_flag /*indicate if current decoded output picture is a base picture*/	u(1)
if(gfv_base_pic_flag) { /*specify TranslatorNN()*/	
gfv_nn_present_flag	u(1)
if(gfv_nn_present_flag) {	
gfv_nn_base_flag	u(1)
gfv_nn_mode_idc	ue(v)
if(gfv_nn_mode_idc == 1) {	
while(!byte_aligned())	
gfv_nn_reserved_zero_bit_a	u(1)
gfv_nn_tag_uri	st(v)
gfv_nn_uri	st(v)
}	
}	
} else /* current decoded output picture is a driving picture*/	
gfv_drive_pic_fusion_flag /*indicate if DrivePicture is input to GenerativeNN()*/	ue(v)
gfv_coordinate_present_flag	u(1)
if(gfv_coordinate_present_flag) {	
gfv_pupil_coordinate_present_idx	u(2)
if(gfv_pupil_coordinate_present_idx != 0) {	
gfv_pupil_coordinate_precision_factor_minus1	ue(v)
gfv_pupil_pred_flag	u(1)

□ gfv_pupil_coordinate_present_idx:

0	No pupil position info.
1	Left pupil position info.
2	Right pupil position info.
3	Both left and right pupil position info.

□ gfv_pupil_coordinate_precision_factor_minus1: plus 1 indicates the length, in bits, of the syntax elements

□ gfv_pupil_pred_flag: indicates whether or not pupil position info. are predicted (=1) or not (=0)



Proposed solution: GFV SEI information changes

▣ Dealing with left pupil position information:

if (gfv_pupil_coordinate_present_idx == 1 gfv_pupil_coordinate_present_idx == 3) {	
if (gfv_pupil_pred_flag) {	
gfv_pupil_left_eye_dx_coordinate_abs	ue(v)
gfv_pupil_left_eye_dx_coordinate_sign_flag	u(1)
gfv_pupil_left_eye_dy_coordinate_abs	ue(v)
gfv_pupil_left_eye_dy_coordinate_sign_flag	u(1)
} else {	
gfv_pupil_left_eye_x_coordinate	ue(v)
gfv_pupil_left_eye_y_coordinate	se(v)
}	
}	

▣ gfv_pupil_pred_flag = 0

▣ gfv_pupil_left_eye_x_coordinate:

indicates the normalized value of the x-axis coordinate of the left eye

The variable leftPupilCoordinateX indicating the x-axis coordinate of the left pupil center position is derived as follows:

$$\text{LeftPupilCoordinateX} = \frac{\text{gfv_pupil_left_eye_x_coordinate} * \text{CornersDistance}}{1 \ll (\text{gfv_pupil_coordinate_precision_factor_minus1} + 1)} + \text{LeftCornerReferenceCoordinateX}$$



Proposed solution: GFV SEI information changes

▣ Dealing with left pupil position information:

if (gfv_pupil_coordinate_present_idx == 1 gfv_pupil_coordinate_present_idx == 3) {	
if (gfv_pupil_pred_flag) {	
gfv_pupil_left_eye_dx_coordinate_abs	ue(v)
gfv_pupil_left_eye_dx_coordinate_sign_flag	u(1)
gfv_pupil_left_eye_dy_coordinate_abs	ue(v)
gfv_pupil_left_eye_dy_coordinate_sign_flag	u(1)
} else {	
gfv_pupil_left_eye_x_coordinate	ue(v)
gfv_pupil_left_eye_y_coordinate	se(v)
}	
}	

- ▣ gfv_pupil_pred_flag = 1
- ▣ gfv_pupil_left_eye_dx_coordinate_abs:
indicates the absolute difference value of the normalized value of the x-axis coordinate of the left eye
- ▣ gfv_pupil_left_eye_dx_coordinate_sign_flag:
specifies the sign of the difference value of the x-axis coordinate of the left eye

0	LeftPupilCoordinateDeltaX is positive
1	LeftPupilCoordinateDeltaX is negative



Proposed solution: GFV SEI information changes

▣ Dealing with left pupil position information:

if (gfv_pupil_coordinate_present_idx == 1 gfv_pupil_coordinate_present_idx == 3) {	
if (gfv_pupil_pred_flag) {	
gfv_pupil_left_eye_dx_coordinate_abs	ue(v)
gfv_pupil_left_eye_dx_coordinate_sign_flag	u(1)
gfv_pupil_left_eye_dy_coordinate_abs	ue(v)
gfv_pupil_left_eye_dy_coordinate_sign_flag	u(1)
} else {	
gfv_pupil_left_eye_x_coordinate	ue(v)
gfv_pupil_left_eye_y_coordinate	se(v)
}	
}	

▣ gfv_pupil_pred_flag = 1

The variable leftPupilCoordinateX indicating the x-axis coordinate of the left pupil center position is derived as follows:

$$\begin{aligned} \text{LeftPupilCoordinateX} = & \\ & \text{LeftPupilCoordinateDeltaX} \\ & + \text{BaseLeftPupilPositionX} \\ & + \text{LeftCornerReferenceCoordinateX} \end{aligned}$$

The variable LeftPupilCoordinateDeltaX indicating the delta x-axis coordinate of the left pupil center position is derived as follows:

$$\text{LeftPupilCoordinateDeltaX} = \frac{(1 - 2 * \text{gfv_pupil_left_eye_dx_coordinate_sign_flag}) * \text{gfv_pupil_left_eye_dx_coordinate_abs} * \text{CornersDistance}}{1 \ll (\text{gfv_pupil_coordinate_precision_factor_minus1} + 1)}$$



Proposed solution: GFV SEI information changes

Dealing with right pupil position information:

if (gfv_pupil_coordinate_present_idx == 2 gfv_pupil_coordinate_present_idx == 3) {	
if (gfv_pupil_pred_flag) {	
gfv_pupil_right_eye_dx_coordinate_abs	ue(v)
gfv_pupil_right_eye_dx_coordinate_sign_flag	u(1)
gfv_pupil_right_eye_dy_coordinate_abs	ue(v)
gfv_pupil_right_eye_dy_coordinate_sign_flag	u(1)
} else {	
gfv_pupil_right_eye_x_coordinate	ue(v)
gfv_pupil_right_eye_y_coordinate	se(v)
}	
}	
}	
gfv_coordinate_precision_factor_minus1	ue(v)
gfv_num_kp_minus1	ue(v)
gfv_kp_pred_flag	u(1)
gfv_coordinate_z_present_flag	u(1)
...	

- gfv_pupil_right_eye_dx_coordinate_abs: indicates the absolute difference value of the normalized value of the x-axis coordinate of the right eye
- gfv_pupil_right_eye_dx_coordinate_sign_flag: specifies the sign of the difference value of the x-axis coordinate of the right eye

0	RightPupilCoordinateDeltaX is positive
1	RightPupilCoordinateDeltaX is negative



Conclusion

- In this contribution, we propose to convey the concept of eye movement information and propose to add the GFV SEI message corresponding to the pupil center position:
 - A pupil position representation is presented
 - Related changes in GFV SEI are proposed
- We suggest to add these modifications into JVET-AG2032.

