

On the future of decoder-side depth estimation in MPEG immersive video coding

Dawid Mieloch
Adrian Dziembowski



Jun Young Jeong
Gwangsoon Lee



Institute of Multimedia Telecommunications, Poznań University of Technology
Electronics and Telecommunications Research Institute

input views
attributes + geometry + cam. params



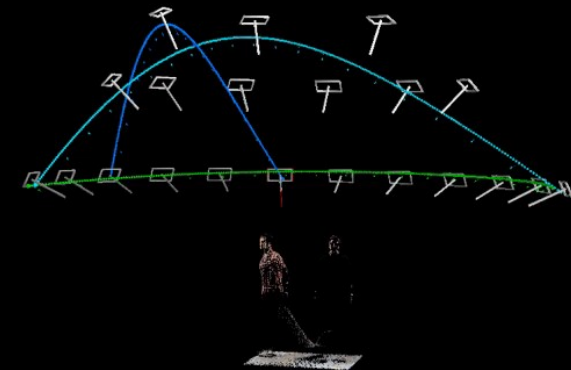
atlases
attributes + geometry + metadata sub-bitstream

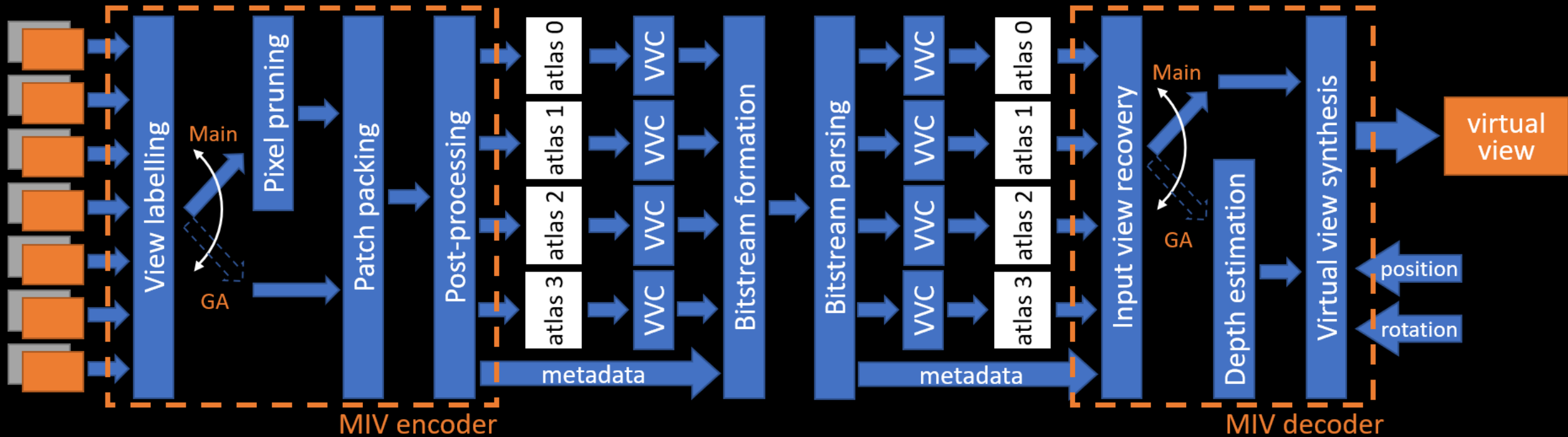


viewport



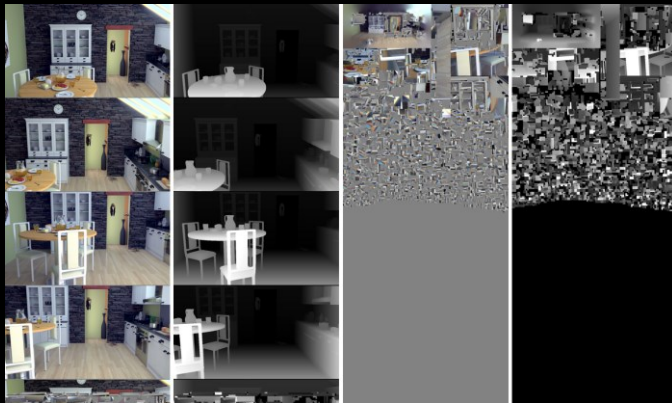
trajectory of the viewer





- Covering all existing and some potential use cases of decoder-side depth estimation
 - Enable depth estimation or depth refinement at the decoder side in more use cases
 - Allow for transmitting partial (or complete) geometry information

MIV Main



MIV Geometry Absent



Proposed MIV DSDE



Geometry Absent + Extended geometry assistance SEI [1]

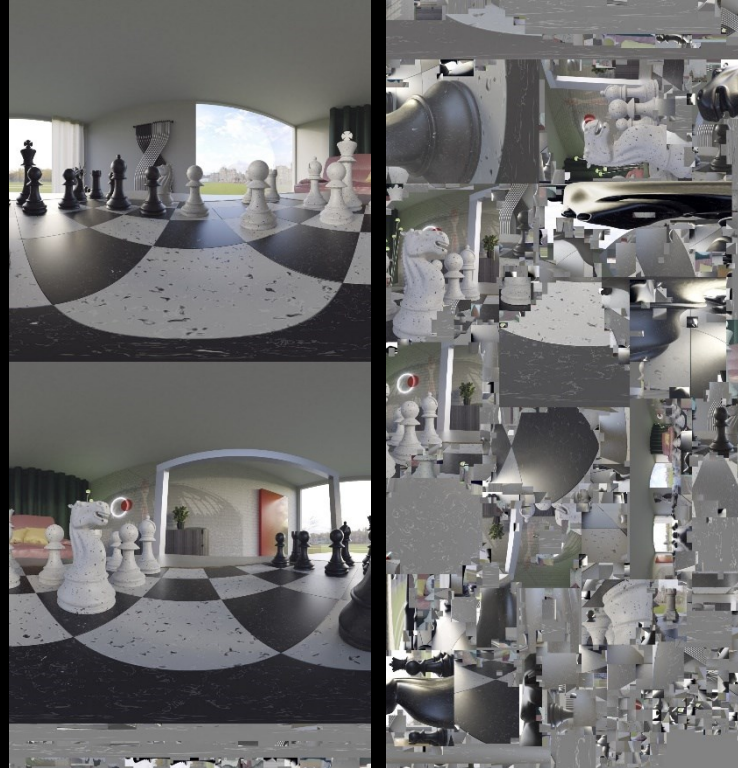
Already included into the MIV ed. 2:

- typical geometry assistance (features sent for all views, no recursion),
- recursive features,
- features sent for a subset of views,
- recursive features sent for a subset of views,
- different level of details for different views
(quantization step, block width, number of splits set per view),
- possibility for adding new schemes of feature extraction
(not only block-based rectangular grid).



[1] A. Dziembowski, D. Mieloch, J.Y. Jeong, G. Lee, "[MIV] Extended geometry assistance SEI", ISO/IEC JTC1/SC29/WG4 MPEG VC M60248, 07.2022

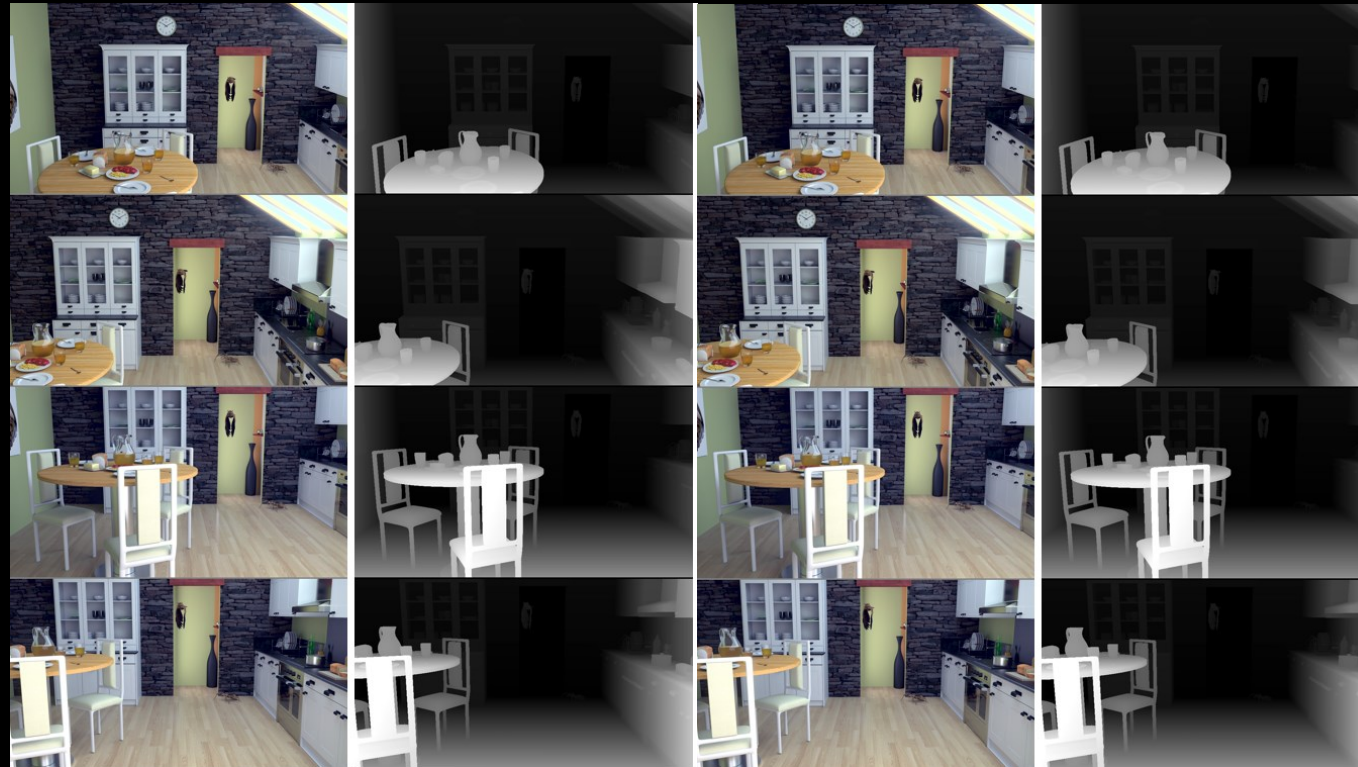
MIV Main with no geometry transmission [2]



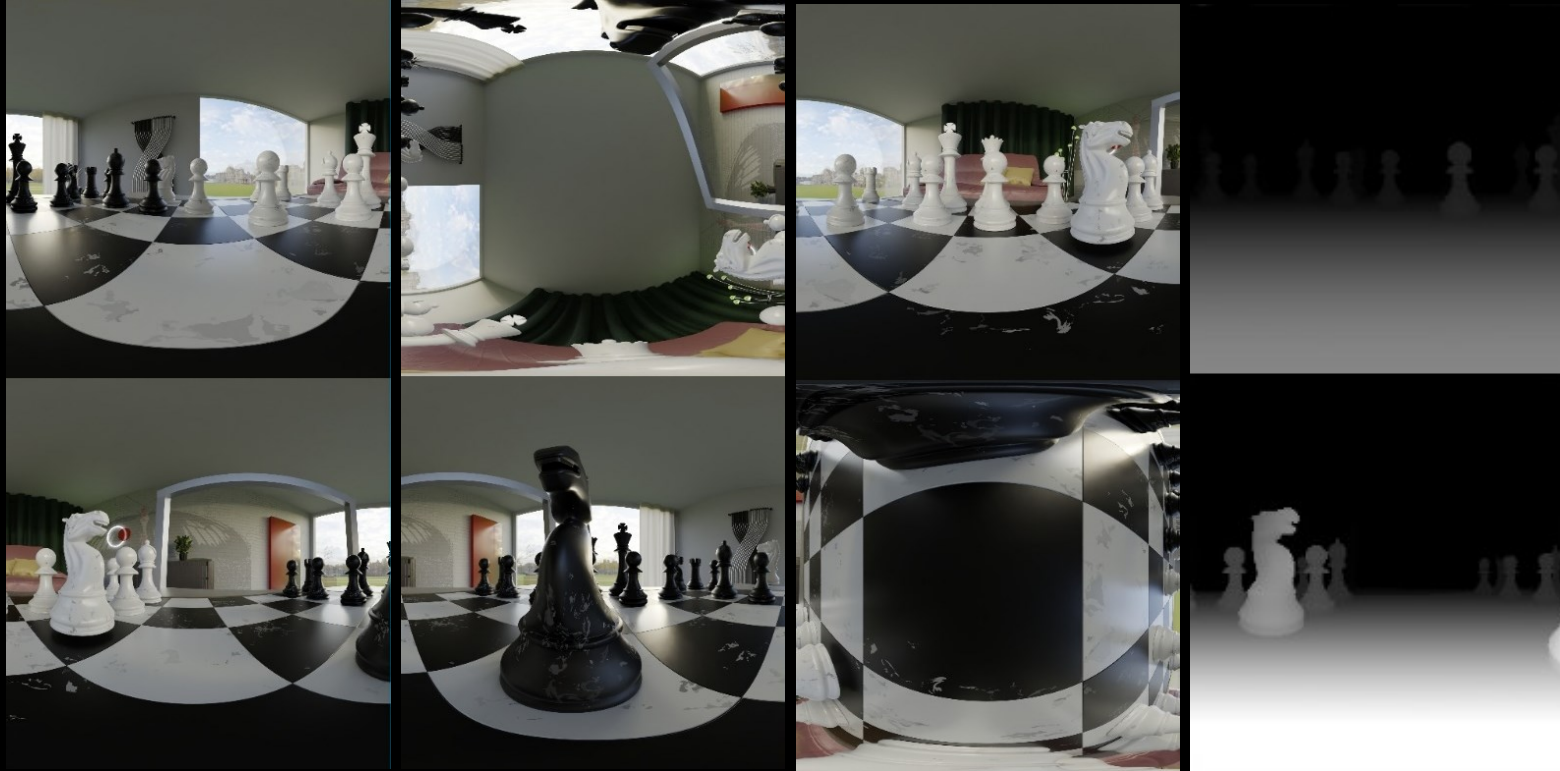
[2] M. Milovanović, F. Henry, M. Cagnazzo and J. Jung, "Patch Decoder-Side Depth Estimation In Mpeg Immersive Video," ICASSP 2021, pp. 1945-1949, 2021.

MIV Main with depth refinement

Post-processing of depth maps treated as decoder-side depth estimation

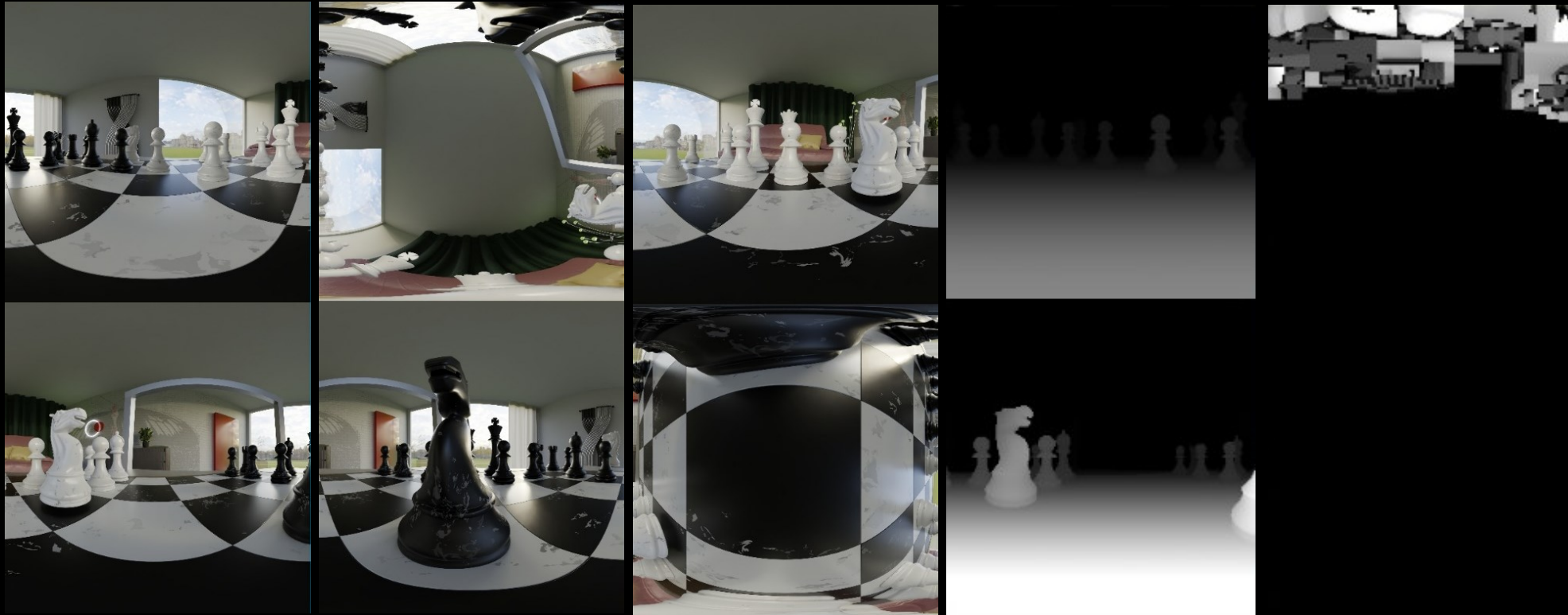


Input depth map assistance [3]



[3] D. Klóska, D. Mieloch, A. Dziembowski, M. Domański, G. Lee, J.Y. Jeong, "Decoder-side depth estimation with input depth assistance", ISO/IEC JTC1/SC29/WG4 MPEG VC M58048, 10.2021.

Extended input depth map assistance [4]

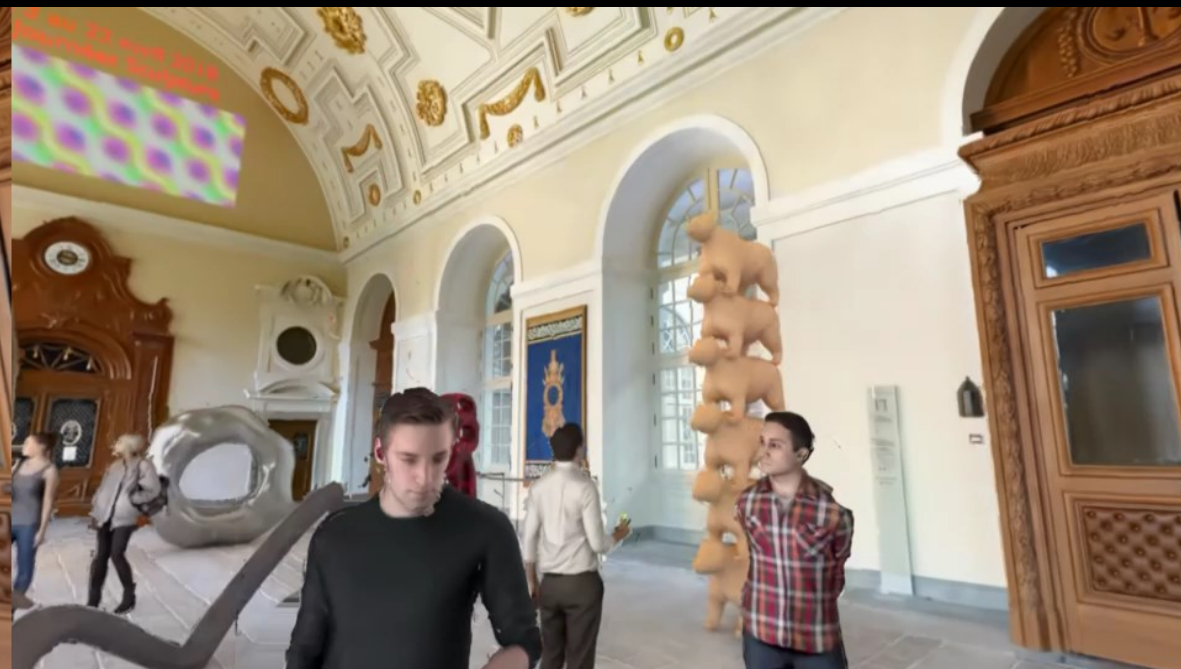


[4] D. Mieloch, A. Dziembowski, B. Szydełko, D. Klóska, G. Lee, J.Y. Jeong, "[MIV] Decoder-side depth estimation with extended input depth assistance", ISO/IEC JTC1/SC29/WG4 MPEG VC M59516, 04.2022.

No assistance



Extended input depth map assistance



On average 3 times faster rendering
(including depth estimation)

No assistance



Extended input depth map assistance



On average 3 times faster rendering
(including depth estimation)

Functionality \ Use case	MIV Geometry Absent (GA)	MIV GA with SEI	MIV Main w/o depth transmission		MIV Main w/ refinement	IDMA: Input depth map asst.	Extended IDMA	Faster ext. IDMA	Usage of depth sensors	MIV Main (no DSDE)
Section of [5]	2.1	2.1.1	2.2	2.3	2.5	2.6	2.7	2.8	2.9	-
Decoder-side depth estimation	yes	yes	yes	yes	partial ¹	yes	yes	partial ²	yes	no
Texture video transmission	yes	yes	yes	yes	yes	yes	yes	yes	partial ³	yes
Texture pruning in encoder	no	no	yes	yes	yes	no	no	no	no	yes
Geometry (depth) video transmission	no	no	no	no	yes	partial ⁴	partial ⁴	partial ⁴	partial ⁴	yes
Geometry pruning in encoder	no	no	no	no	yes	no	yes	yes	no	yes
External occupancy video transmission	no	no	no	yes	no	no	no	no	no	no
Additional (non-video) depth information	no	yes	no	no	no	no	no	no	no	no
Depth reprojection in decoder	no	no	no	no	no	no	yes	yes	yes	no

¹ Only depth refinement (reestimation); ² Depth estimated only for fragments of the depth maps; ³ Bitstream contains geometry videos which do not correspond to any texture video; ⁴ Bitstream contains texture videos which do not correspond to any geometry video.

[6] A. Dziembowski, D. Mieloch, J.Y. Jeong, G. Lee, "MIV Decoder-Side Depth Estimation profile," ISO/IEC JTC1/SC29/WG4 MPEG VC M60667, Mainz, 10.2022, available at: <http://multimedia.edu.pl/m60667>

	MIV Geometry Absent (GA)	MIV GA with SEI	MIV Main w/o depth transmission		MIV Main w/ refinement	IDMA: Input depth map asst.	Extended IDMA	Faster ext. IDMA	Usage of depth sensors	MIV Main (no DSDE)
Section of [5]	2.1	2.1.1	2.2	2.3	2.5	2.6	2.7	2.8	2.9	-
Syntax element	2.1	2.1.1	2.2	2.3	2.5	2.6	2.7	2.8	2.9	-
ai_attribute_count[atlasID]	1,1,1,1 ¹		1,1	1,1	1,1	1,1,1	1,1,1,0	1,1,1,0	1,1,1,0	1,1
vps_geometry_video_present_flag[atlasID]	0,0,0,0		0,0	0,0	1,1	1,0,0	1,0,0,1	1,0,0,1	0,0,0,1	1,1
vps_occupancy_video_present_flag[atlasID]	0,0,0,0		0,0	1,1	0,0	0,0,0	0,0,0,0	0,0,0,0	0,0,0,0	0,0
vme_embedded_occupancy_enabled_flag	0		0	0	1	1	1	1	1	1
casme_decoder_side_depth_estimation_flag	1		1	1	1	1	1	1	1	0
V3C SEI payloadType	-	133/134 ²	-	-	-	-	-	-	-	-
mvp_depth_reprojection_flag	0		0	0	0	0	1	1	1	-
mvp_reestimate_all_geometry_flag	1		1	1	1	1	1	0	0	-
mvp_keep_transmitted_geometry_flag[v]	-		-	-	-	-	-	1	1	-
mvp_keep_reprojected_geometry_flag[v]	-		-	-	-	-	-	0/1 ³	0/1	-

¹ Notation “1,1,1,0” means, that a flag is true for atlases 0, 1, and 2, and false for atlas 3.

² payloadType equal to 133 indicates geometry assistance SEI, 134: extended geometry assistance SEI.

³ The flag may be set to 0 or 1 for each view *v*, depending on its quality and desired computational time reduction.

[6] A. Dziembowski, D. Mieloch, J.Y. Jeong, G. Lee, “MIV Decoder-Side Depth Estimation profile,” ISO/IEC JTC1/SC29/WG4 MPEG VC M60667, Mainz, 10.2022, available at: <http://multimedia.edu.pl/m60667>

- The first review of state-of-the-art compression methods based on decoder-side depth estimation.
- New MIV Extended Decoder-Side Depth Estimation profile (already adopted to incoming MIV ed.2) allows for using all reviewed compression methods but also is as future-proof as possible.
- Features of MIV DSDE enable the continuous improvement of the efficiency of incoming MIV ed. 2, even after the standard will reach its final stage.
- Both the already adopted parts of the profile and the additional flags were proposed by the Authors during the 140th MPEG meeting.

Additional information:

- Meet me on poster session in Snowbird
- Mail me: dawid.mieloch@put.poznan.pl
- Read more on MIV: <https://mpeg-miv.org>