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PATCH-BASED END-TO-END IMAGE LEARNED CODECS USING OVERLAPPING

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Captivate your audience

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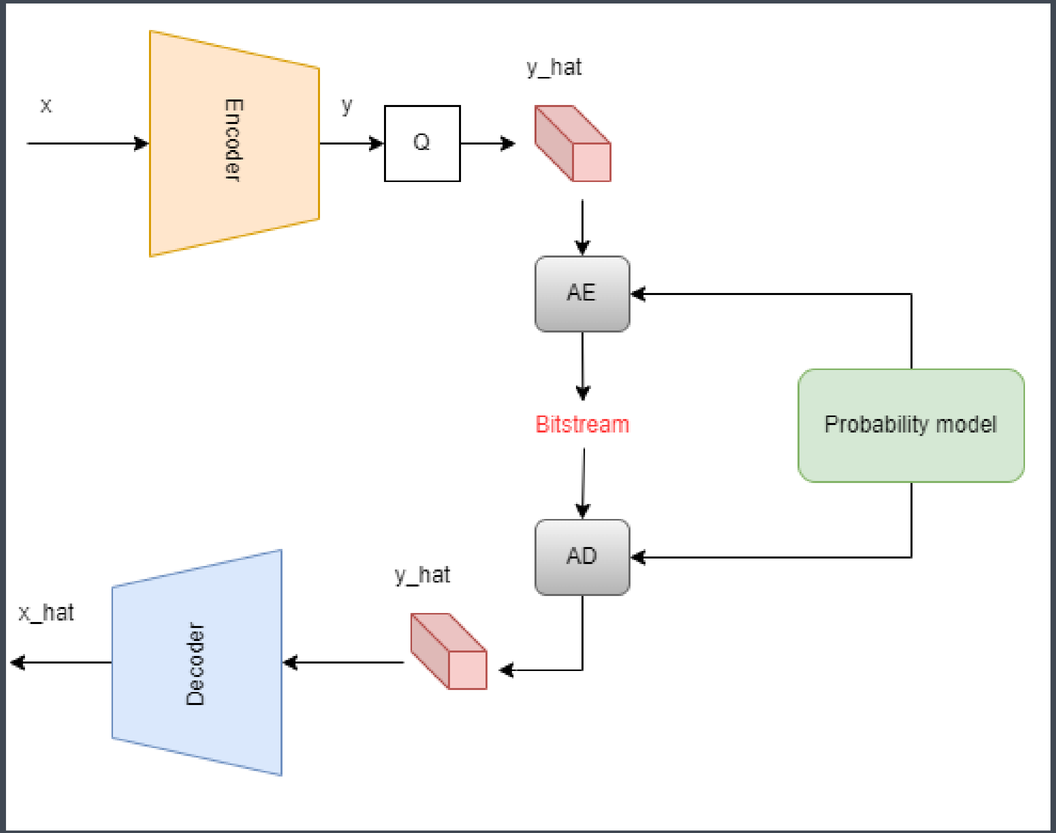
OUTLINE

1. End-to-end Learned image codecs
2. Patch-based End-to-end image learned codecs using Overlapping
3. Results
4. Conclusion

END-TO-END IMAGE LEARNED CODECS

- End-to-end image learned codecs based on auto-encoder architecture
- Encoder : Transform the input image x to a latent representation y
- Probability model : Estimation the probability distribution of the latent representation
- Decoder : Recontruct the input image from the latent representation



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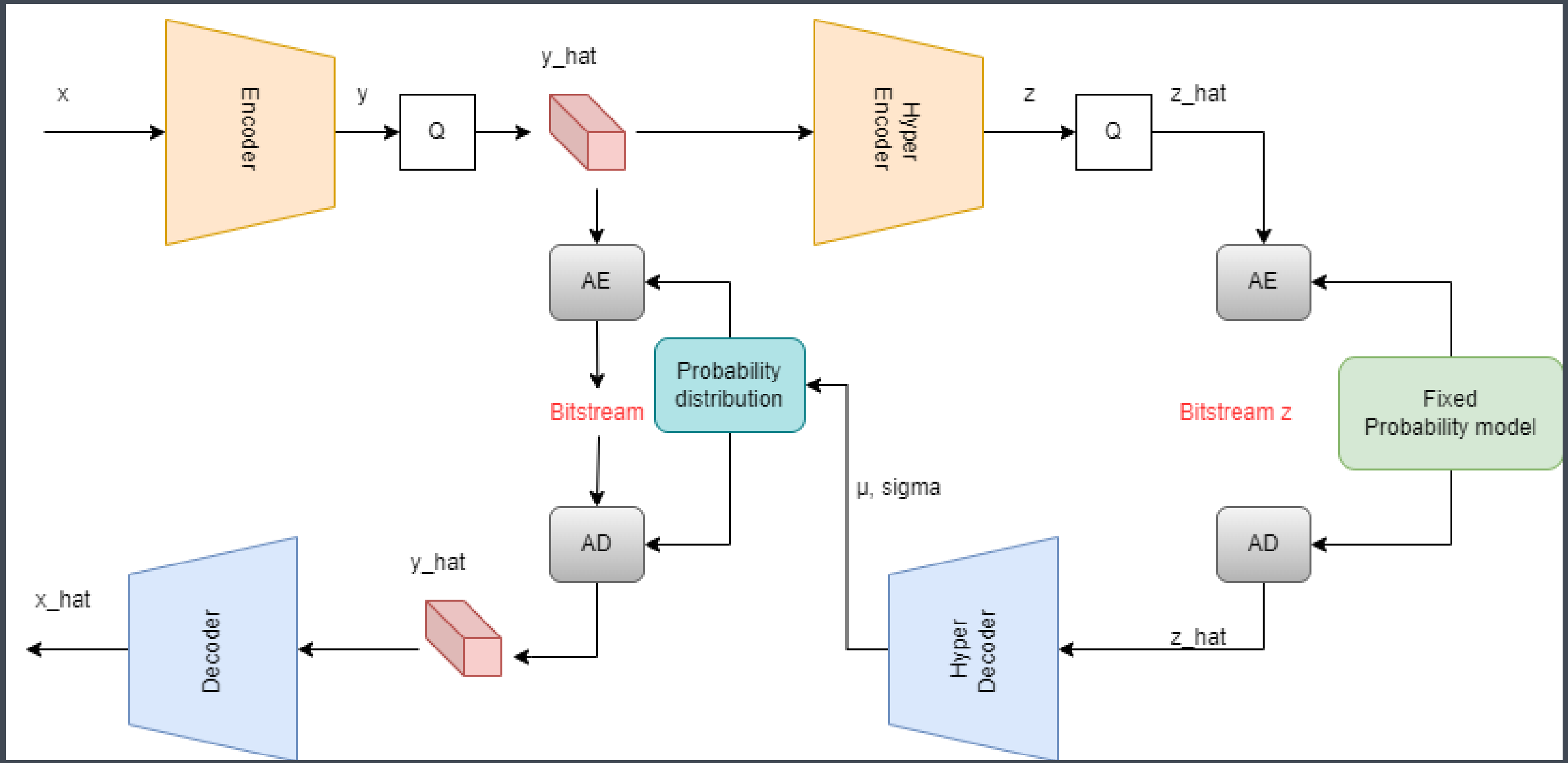
END-TO-END IMAGE LEARNED CODECS



[1] J. Balle, D. Minnen, S. Singh, and N.Johnston S.J Hwan,
“Variational image compression with a scale hyper-prior,” ICLR 2018 - Conference Track Proceedings, 2018.

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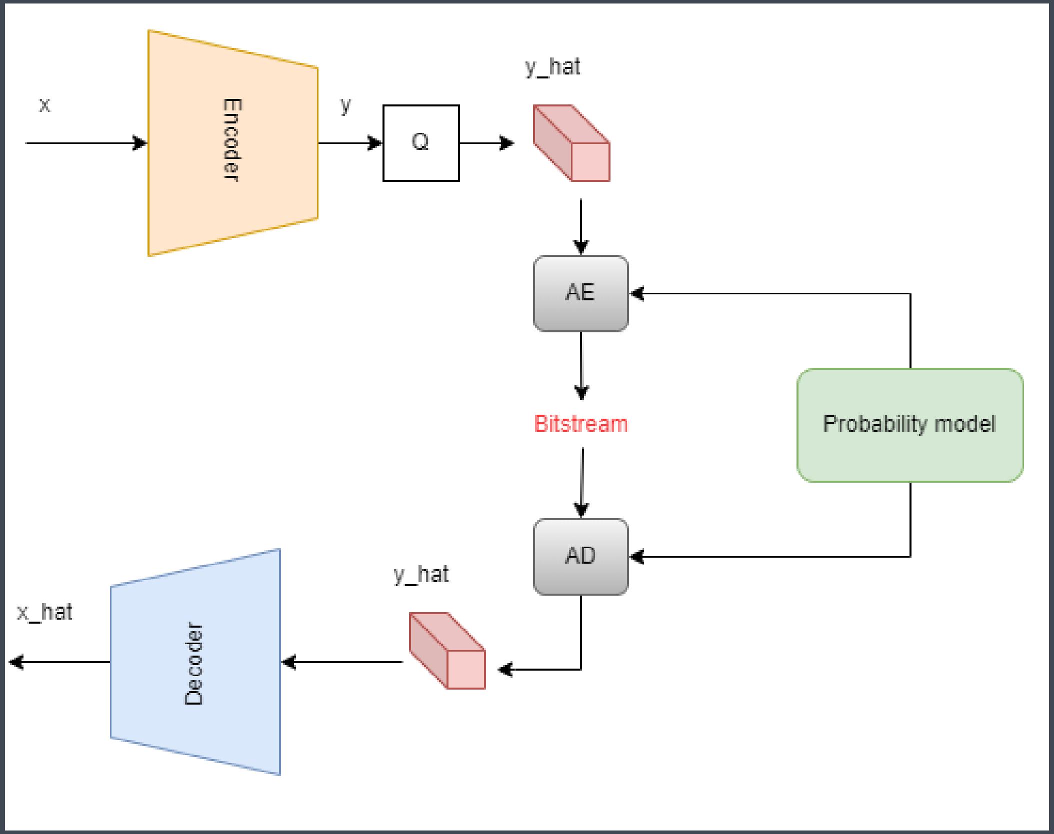
END-TO-END IMAGE LEARNED CODECS : LIMITATIONS

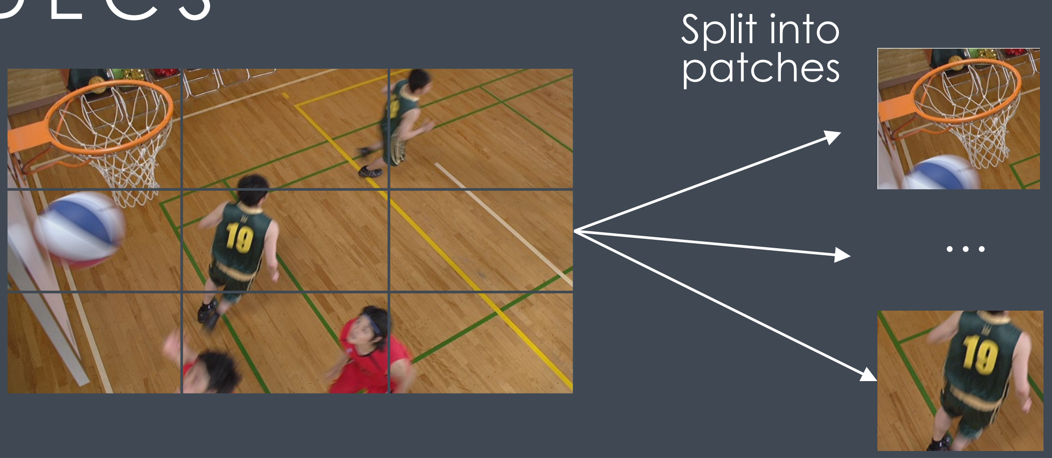


Architecture allows multi-resolution image coding.

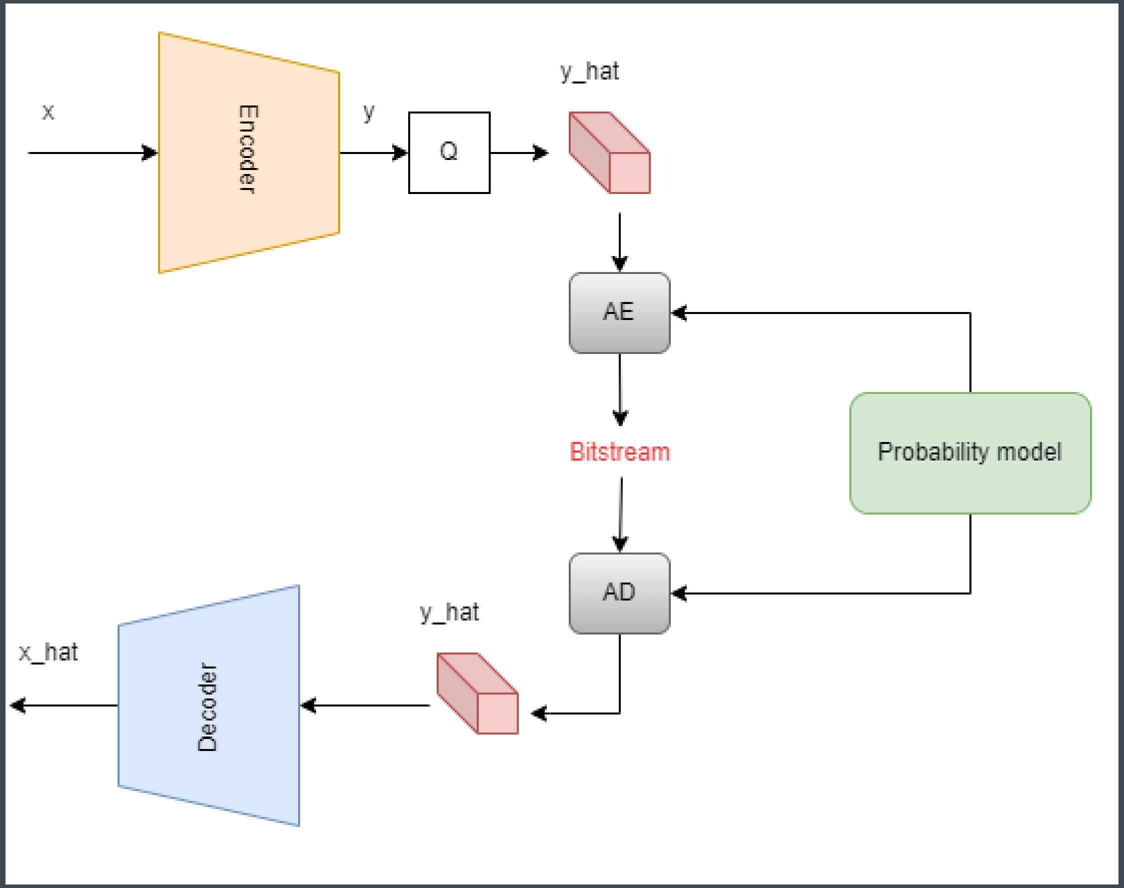
Hardware limitation (memory saturation) for big resolutions

Ex : OOM error for coding HD Image on GPU 2080ti with 11Go

PATCH-BASED END-TO-END IMAGE LEARNED CODECS



Border artifacts



PATCH-BASED END-TO-END IMAGE LEARNED CODECS USING OVERLAPPING

Goal

- Benefit from the advantages of patch-based solutions to address the hardware limitation
- Eliminate Border artifacts from the decoded images

Contribution

- Patch-based end-to-end learned image codec using overlapping method
- The proposed method is compatible with any learned codec based on an auto-encoder architecture

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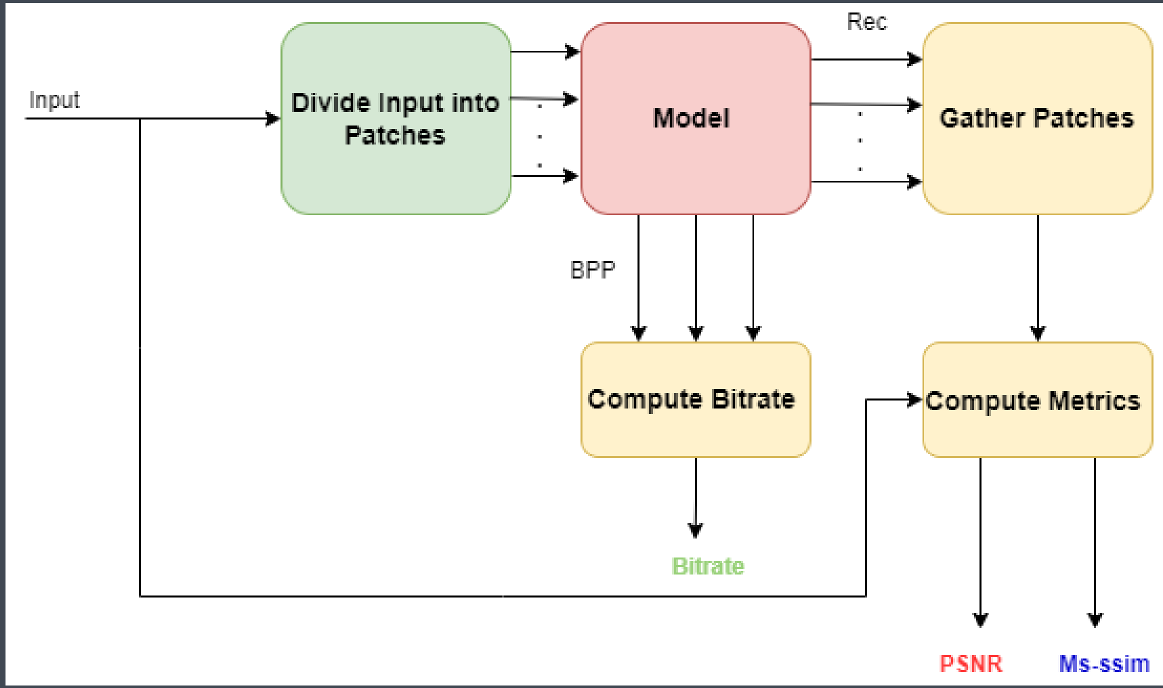
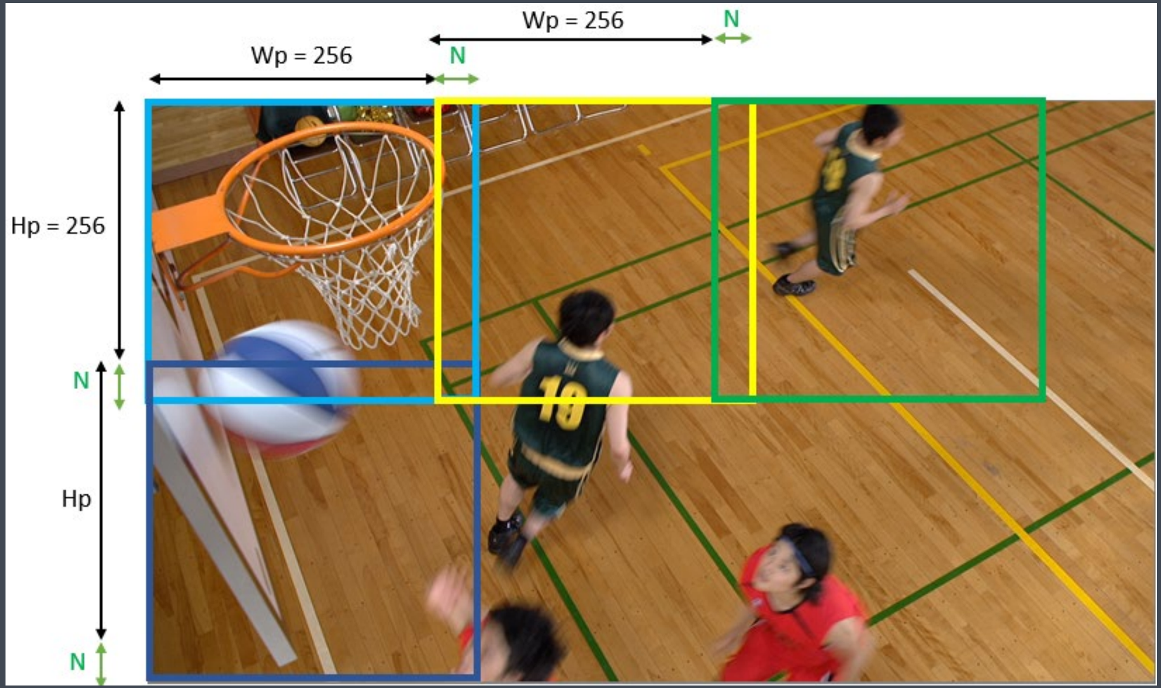
PATCH-BASED END-TO-END IMAGE LEARNED CODECS USING OVERLAPPING



Steps to patch-based image coding



Divide into patches

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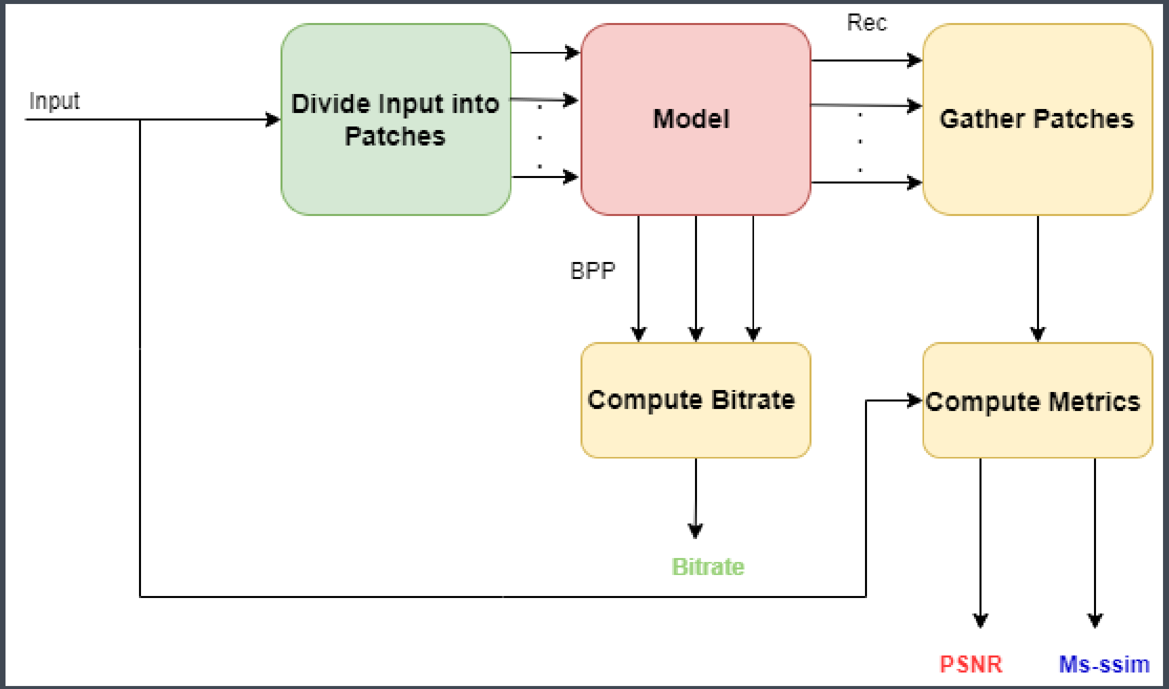
PATCH-BASED END-TO-END IMAGE LEARNED CODECS USING OVERLAPPING



Steps to patch-based image coding

- End-to-end model is an implementation of cheng 2020 [2].
- Training process :
  - Dataset : Clic 2020
  - Training resolution : 256x256
  - Total number of steps 500 000
- Loss function :

$$J = D + \lambda R$$

  - D : distorsion measured By MSE or MS-SSIM
  - R : rate used to transmit the bitstream, estimated using the shannon entropy
  - λ Lagrangian multipliers

Model

[2] Z. Cheng, H. Sun, M. Takeuchi, and J. Katto, "Learned image compression with discretized gaussian mixture likelihoods and attention modules," Proceedings of the IEEE Computer Society Conference on Computer Vision and Pattern Recognition, pp. 7936–7945, 2020.

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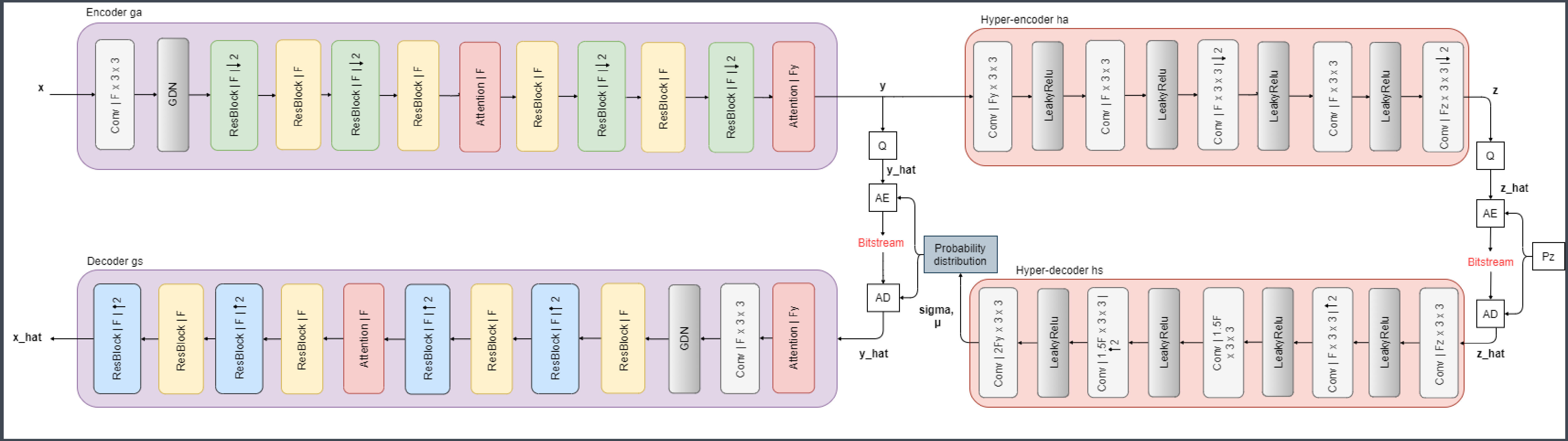
END-TO-END MODEL ARCHITECTURE



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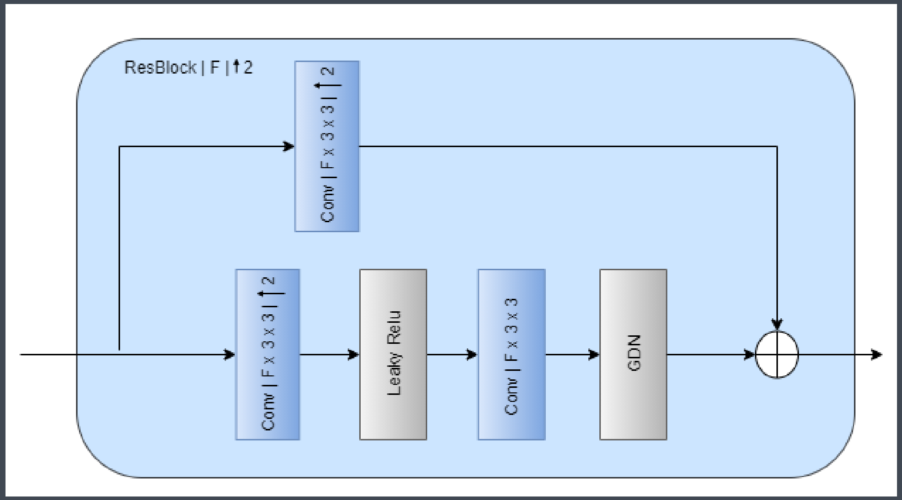
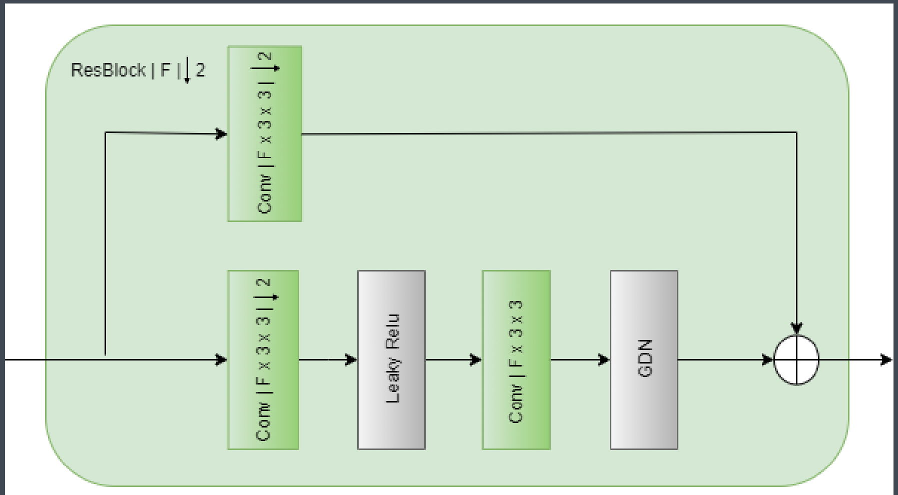
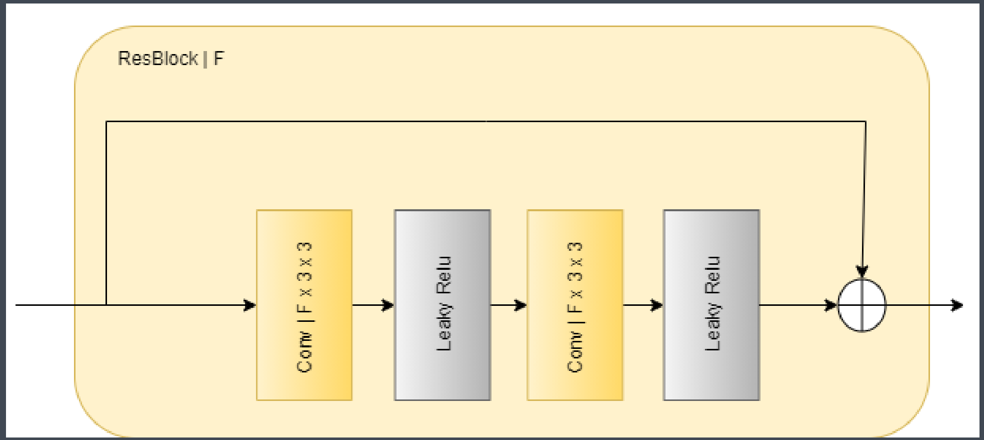
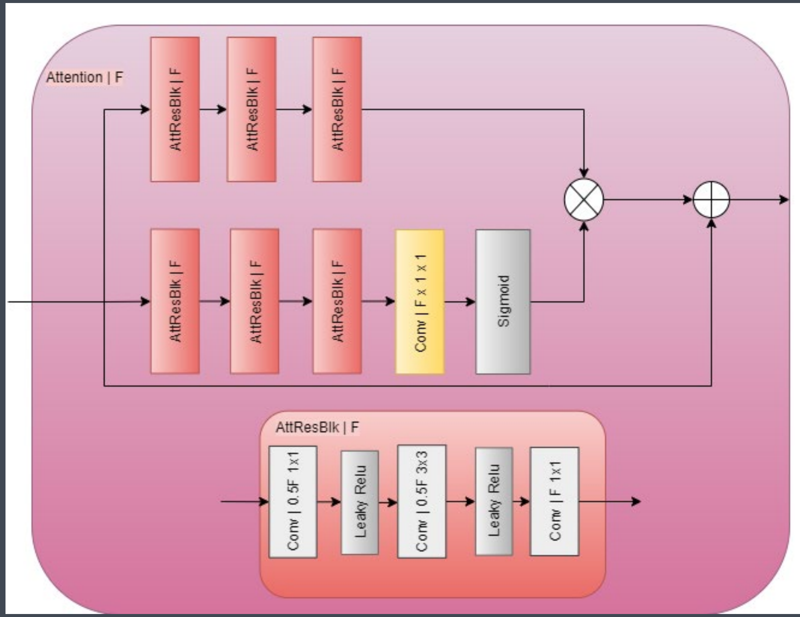
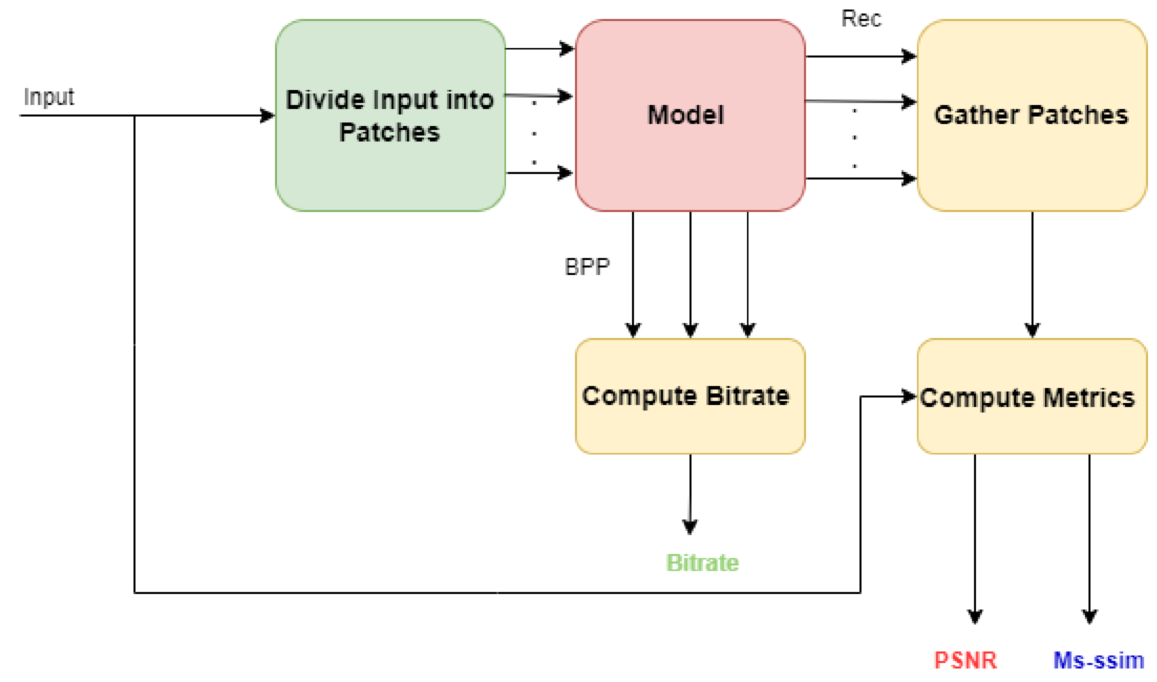




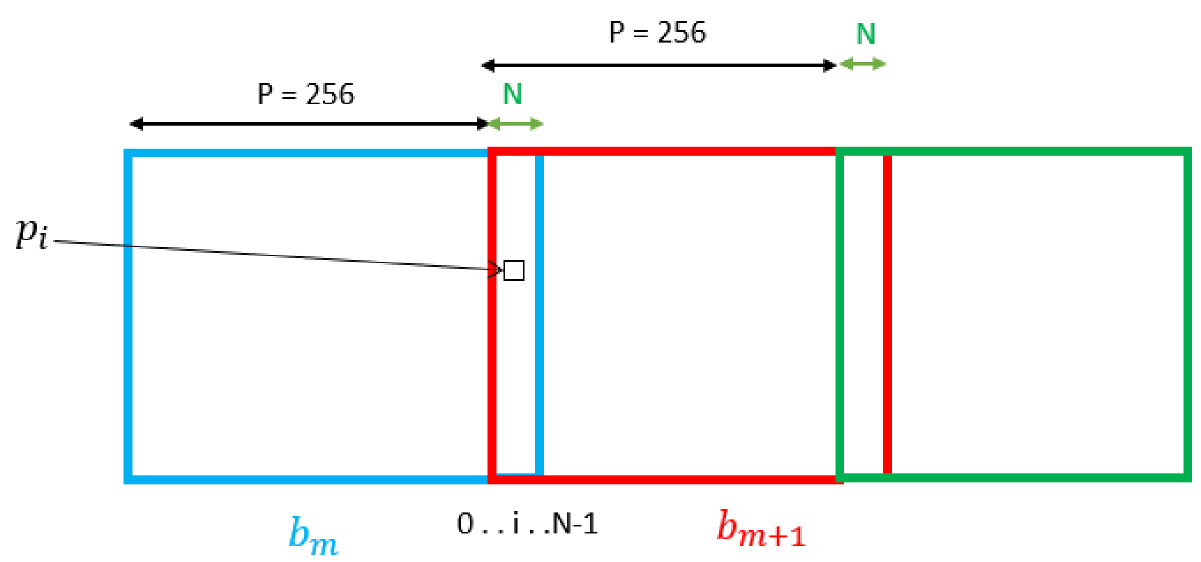




PATCH-BASED END-TO-END IMAGE LEARNED CODECS USING OVERLAPPING



Steps to patch-based image coding



$$p_i = (1 - \frac{i}{N-1})p_{b_m}(P+i) + (\frac{i}{N-1})p_{b_{m+1}}(i)$$

Gathering patches

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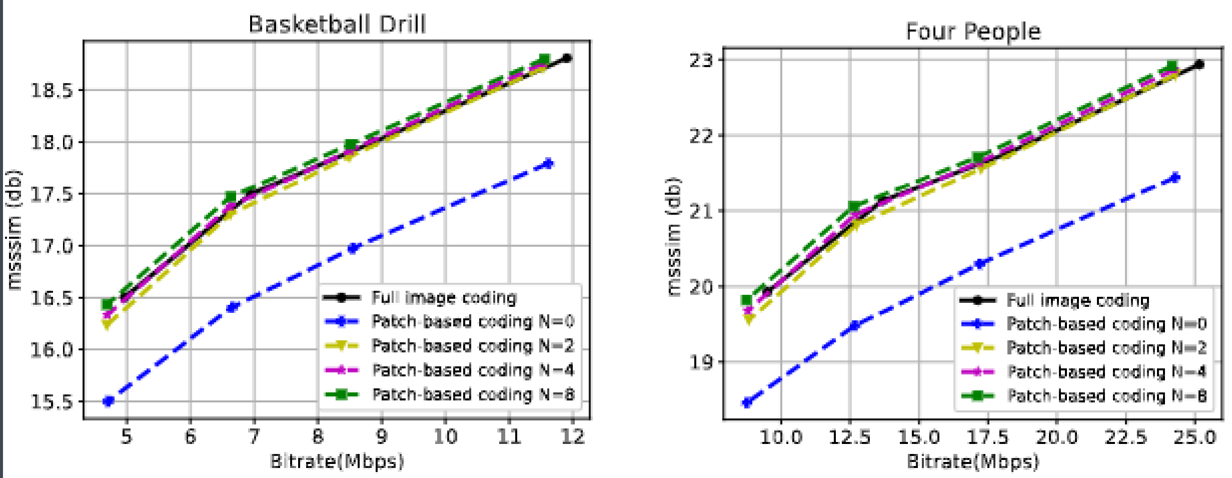
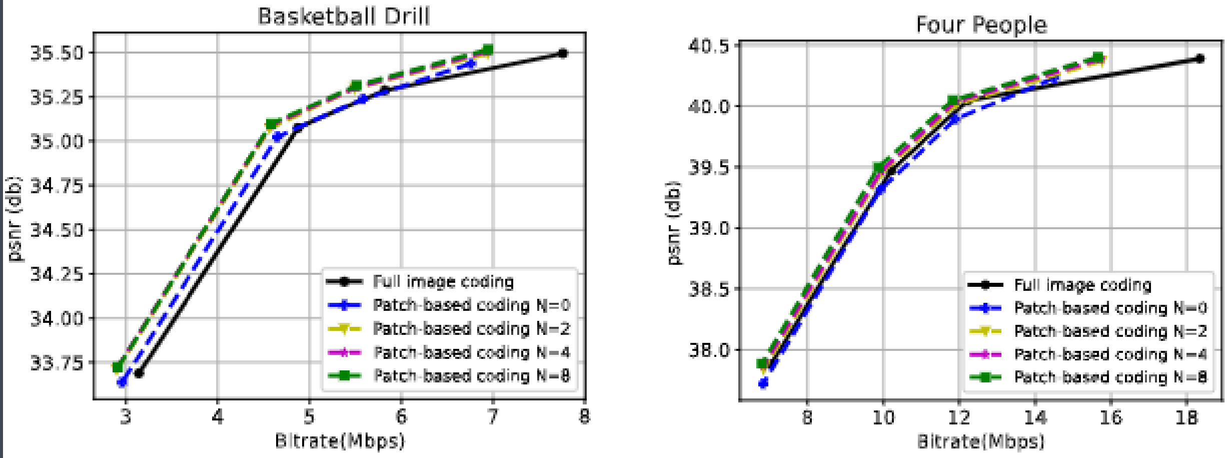
EVALUATION PROCESS

- Models : Eight models were trained. 4 for each quality metric (MSE and MS-SSIM) .
  - Metric MSE : $\lambda = \{4096, 3140, 2048, 1024\}$
  - Metric MS-SSIM : $\lambda = \{420, 220, 120, 64\}$
- Evaluation Sequences : Frame extracted from JVET Common Test Condition (CTC).
- Frame is compressed in :
  - Full resolution
  - Per patch without overlapping
  - Per patch with overlapping $N \in \{2, 4, 8, 16, 32\}$

RESULTS



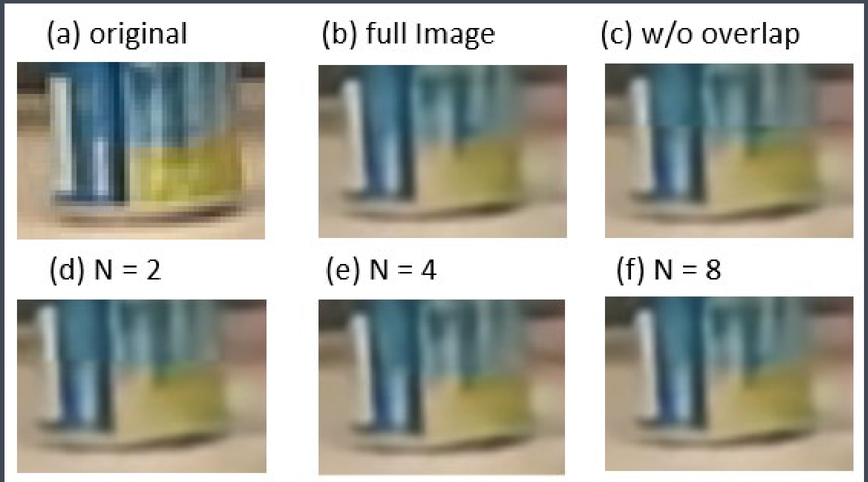
(a) MS-SSIM Rate-Distortion results



(b) PSNR Rate-Distortion results

Rate-distorsion Results

Visual results for MS-SSIM models



Visual results for MSE models

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RESULTS

BD-rate (MS-SSIM) gains of patch-based coding schemes compared to full resolution coding system for CTC sequences.

	Patch w/o Overlapping	Patch with Overlapping				
		N = 2	N = 4	N = 8	N = 16	N = 32
Class B	0.649	0.029	-0.009	-0.046	-0.066	-0.066
Class C	0.536	0.030	0.0002	-0.029	-0.044	-0.041
Class D	0.231	0.022	0.008	-0.009	-0.016	-0.013
Class E	0.958	0.057	0.016	-0.021	-0.045	-0.047
Class F	0.685	0.045	0.010	-0.018	-0.033	-0.032

BD-rate (PSNR) gains of patch-based coding schemes compared to full resolution coding system for CTC sequences.

	Patch w/o Overlapping	Patch with Overlapping				
		N = 2	N = 4	N = 8	N = 16	N = 32
Class B	-0,006	-0.061	-0.067	-0.072	-0.080	-0.074
Class C	0,0065	-0.030	-0.035	-0.038	-0.040	-0.035
Class D	0,0042	-0.010	-0.011	-0.014	-0.014	-0.007
Class E	0.035	-0.002	-0.014	-0.027	-0.050	-0.036
Class F	0.030	-0.022	-0.025	-0.027	-0.030	-0.023

BD-rate Results

CONCLUSION

- Hardware problem addressed.
- Block artifacts removed.
- Slight gains are observed comparing to Full resolution coding
- Other applications of this method such as denoising.

REFERENCES

- [1] J. Balle, D. Minnen, S. Singh, and N.Johnston S.J Hwan, “Variational image compression with a scale hyper-prior,” ICLR 2018 - Conference Track Proceedings, 2018.

- [2] Z. Cheng, H. Sun, M. Takeuchi, and J. Katto, “Learned image compression with discretized gaussian mixture likelihoods and attention modules,” Proceedings of the IEEE Computer Society Conference on Computer Vision and Pattern Recognition, pp. 7936–7945, 2020.

- [3] “Workshop and c. on learned image compression,” Https://www.compression.cc/, 2020.

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THANK YOU FOR YOUR ATTENTION

RESULTS

Resolution	Method	Coding Time GPU 2080 11Go	Coding time GPU 3090 24Go	Total Number of patches	Batch size	N
HD	Full Resolution	OOM	OOM	-	-	-
	Patch in parallel w/o overlaping	3.40s	1.967s	40	8	-
	Patch in parallel with overlaping	3.82s	2.05s		8	16
	Patch sequentially with overlaping	6.15s	2.861s		-	16
1280x720	Full Resolution	OOM	0.93s	-	-	-
	Patch in parallel w/o overlaping	1.75s	0.95s	15	5	-
	Patch in parallel with overlaping	1.91s	1.012s		5	16
	Patch sequentially with overlaping	2.73s	1.25s		-	16
832x480	Full Resolution	1.06s	0.52	-	-	-
	Patch in parallel w/o overlaping	1.05s	0.54s	8	8	-
	Patch in parallel with overlaping	1.109s	0.55s		8	16
	Patch sequentially with overlaping	1.586s	0.70s		-	16

Coding time Results