Invisible Yet Invincible: A Deep Learning Approach to Image Watermarking

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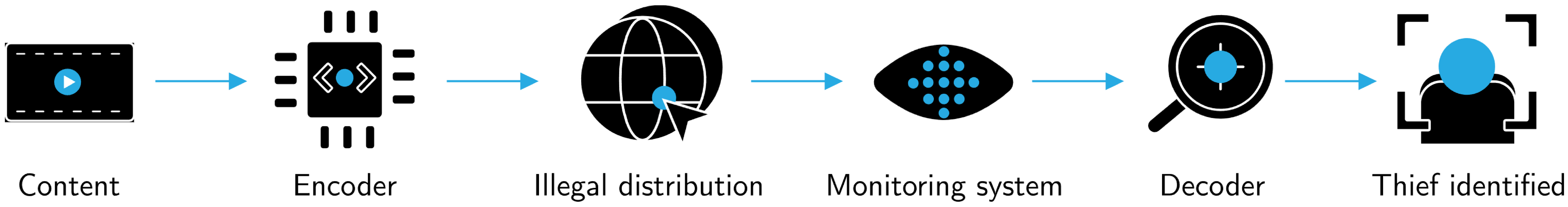
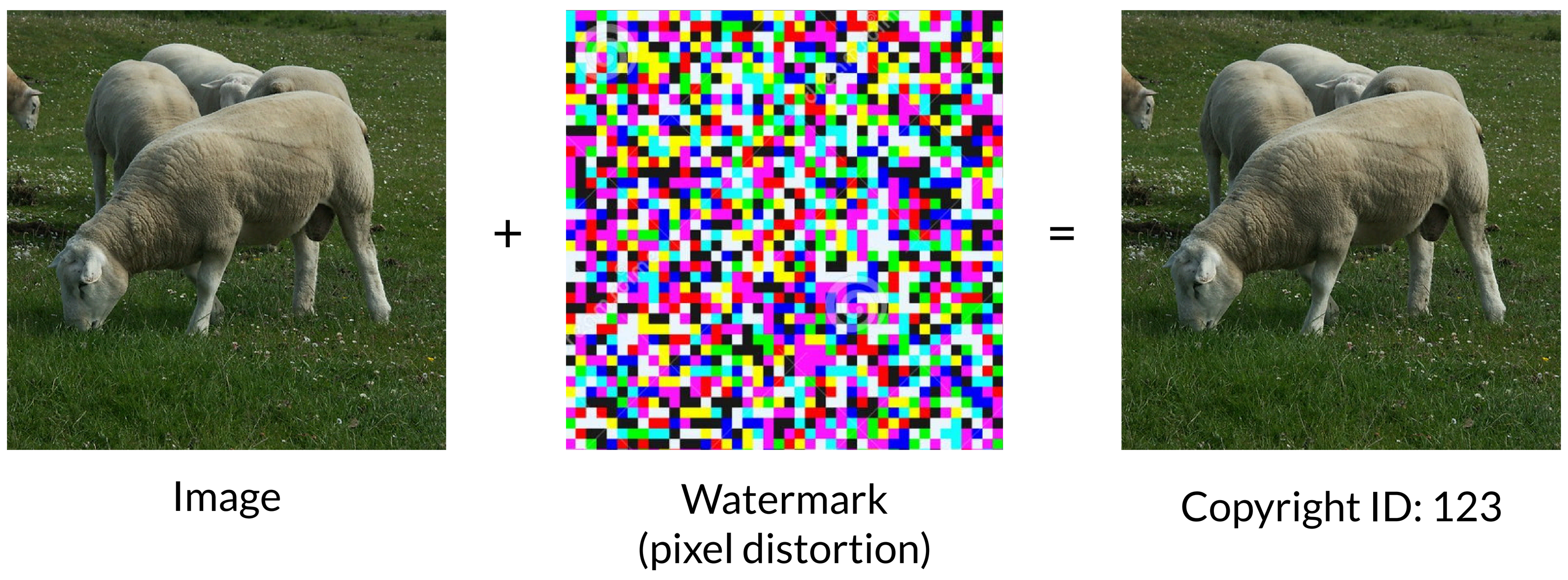
*with Vestigit at the time of the study



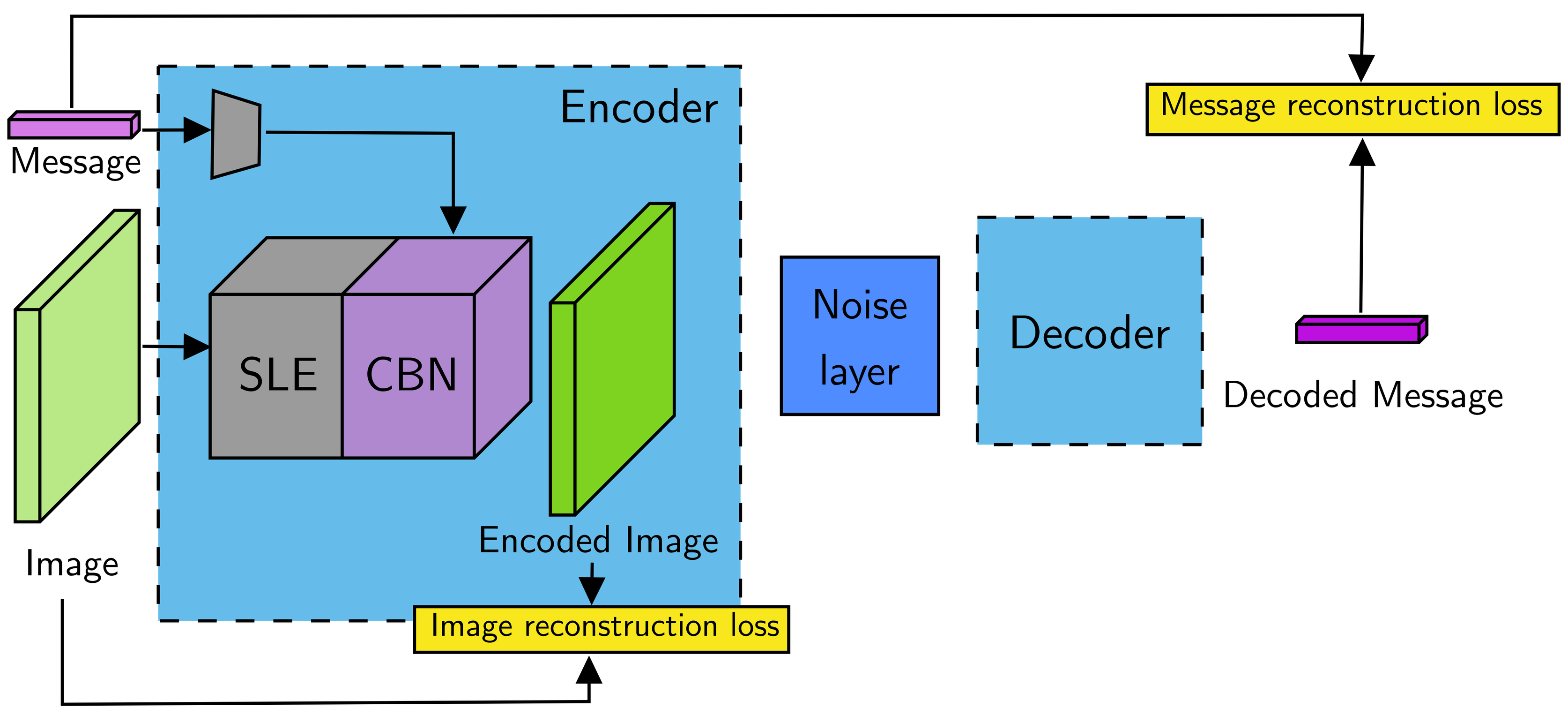
Motivation

- Digital piracy causes massive financial losses in the entertainment industry.
- Traditional watermarking methods struggle with robustness, imperceptibility, and efficiency.
- Our approach ensures a more resilient and efficient watermarking solution against digital piracy.

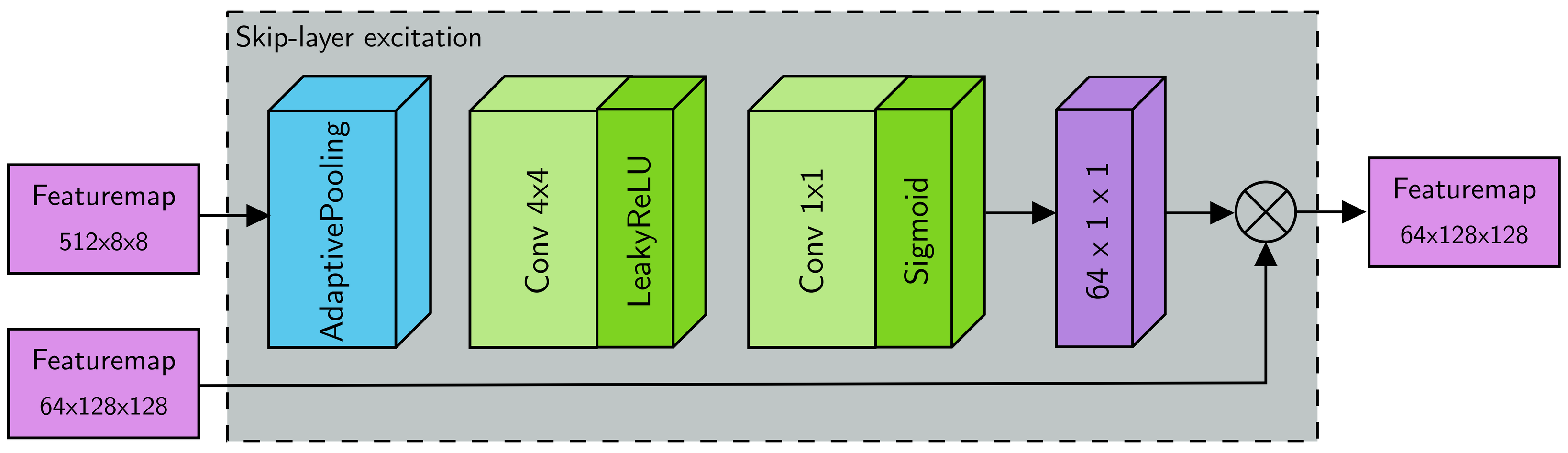
Watermark



Architecture

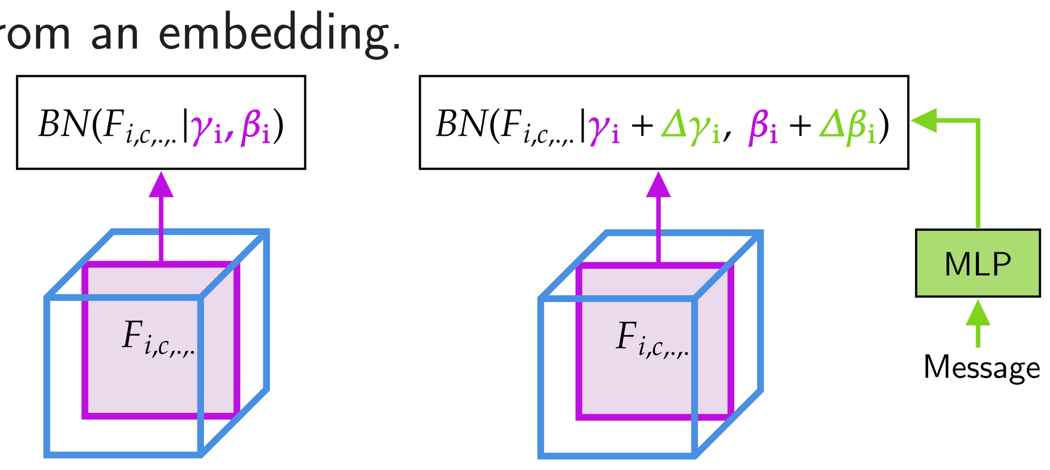


Skip-Layer Excitation

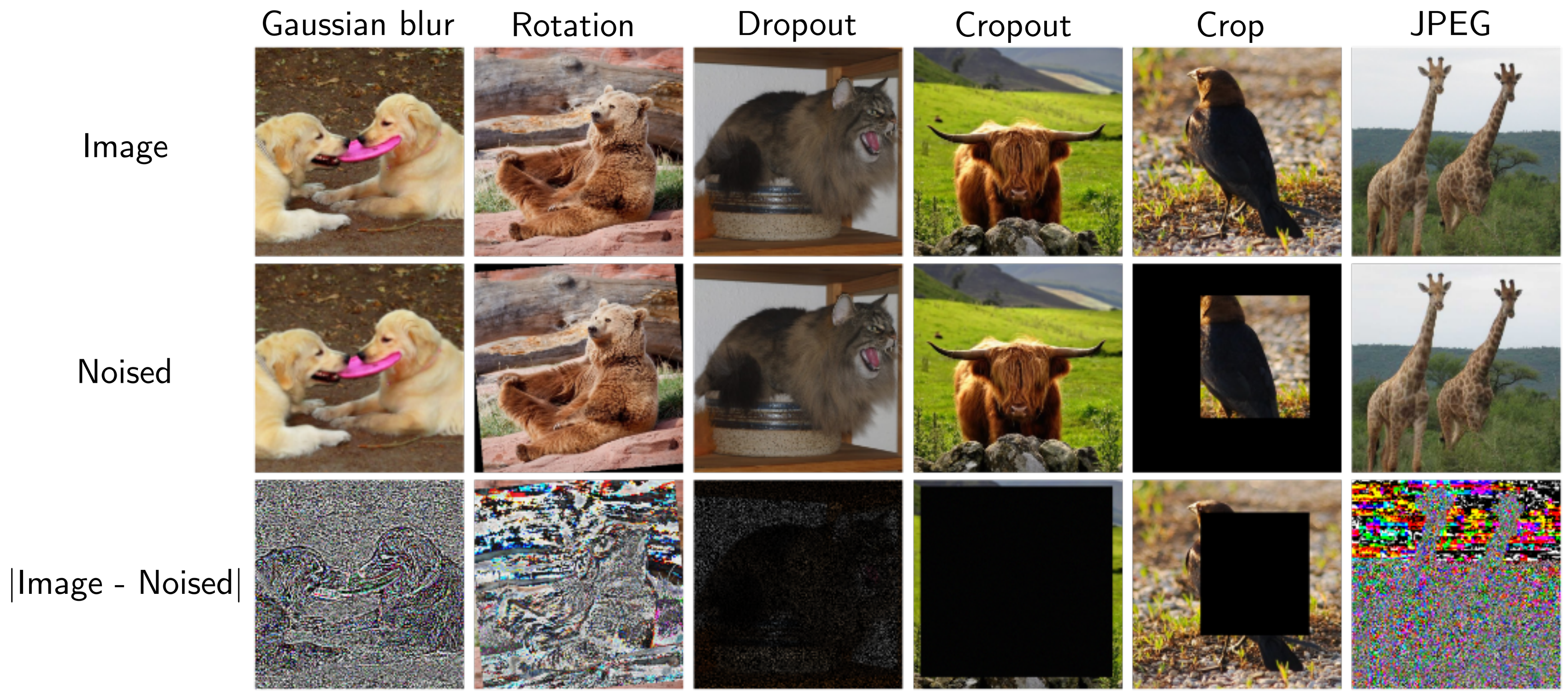


Conditional Batch Normalization

CBN [4] is a class conditional variant of BN. The key idea is to predict the γ_c and β_c from an embedding.

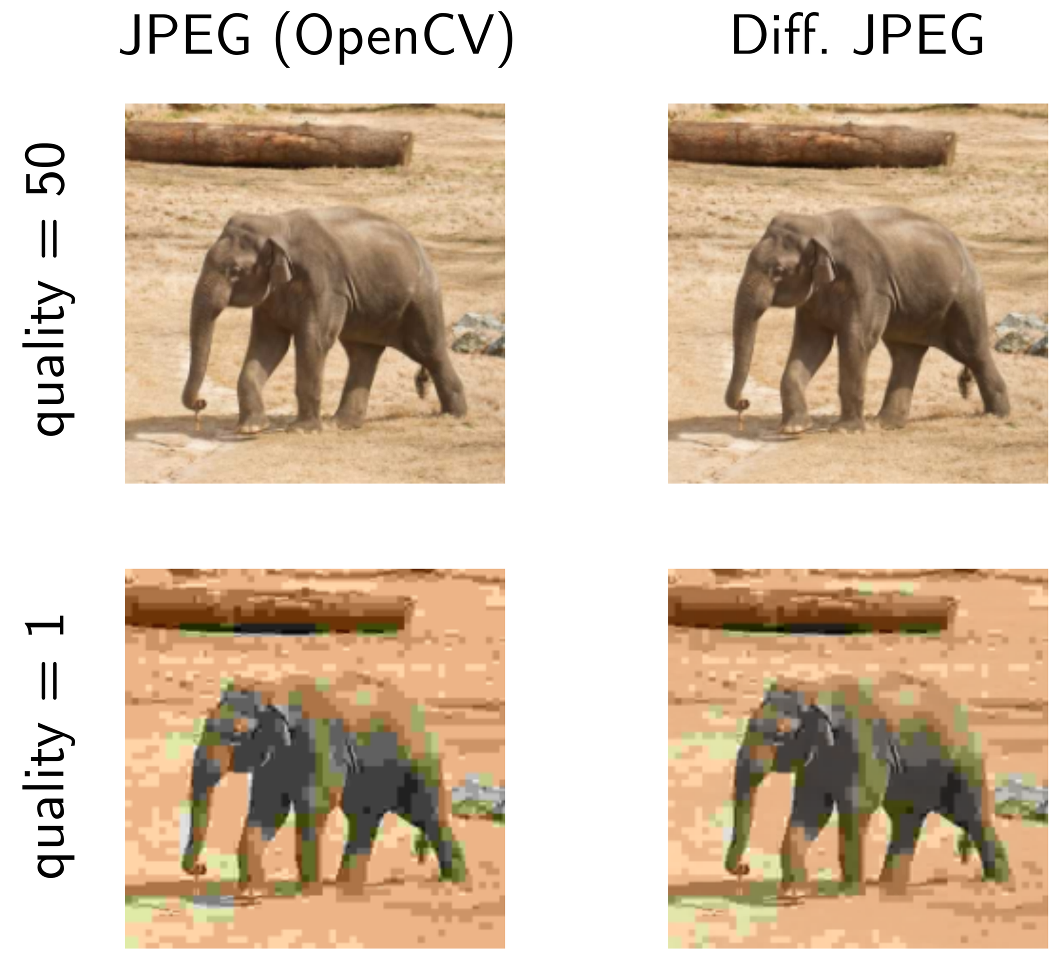


Noise layers



Differentiable JPEG

JPEG encoding/decoding is non-differentiable because it is inherently discrete [2].



Results

The model was evaluated alongside the Watermark Anything Model [3] and HiDDeN [5] on the first 10K validation images of the COCO validation set, using 32-bit messages.

Metric	HiDDeN	WAM	**Ours**
PSNR ↑	38.2	38.3	44.1
SSIM ↑	0.98	0.99	0.99
LPIPS ↓	0.05	0.04	0.01
Bit acc. ↑	95.5	100	99.9

References

[1] Bingchen Liu et al. "Towards Faster and Stabilized GAN Training for High-fidelity Few-shot Image Synthesis". In: *International Conference on Learning Representations*. 2021.

[2] Christoph Reich et al. "Differentiable jpeg: The devil is in the details". In: *Proceedings of the IEEE/CVF Winter Conference on Applications of Computer Vision*. 2024, pp. 4126–4135.

[3] Tom Sander et al. "Watermark Anything With Localized Messages". In: *The Thirteenth International Conference on Learning Representations*. 2025.

[4] Harm de Vries et al. "Modulating early visual processing by language". In: *Advances in Neural Information Processing Systems*. Ed. by I. Guyon et al. Vol. 30. Curran Associates, Inc., 2017.

[5] Jiren Zhu et al. "Hidden: Hiding data with deep networks". In: *Proceedings of the European conference on computer vision (ECCV)*. 2018, pp. 657–672.

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