LMM-driven Semantic Image-Text Coding for Ultra-low Bitrate Learned Image Compression

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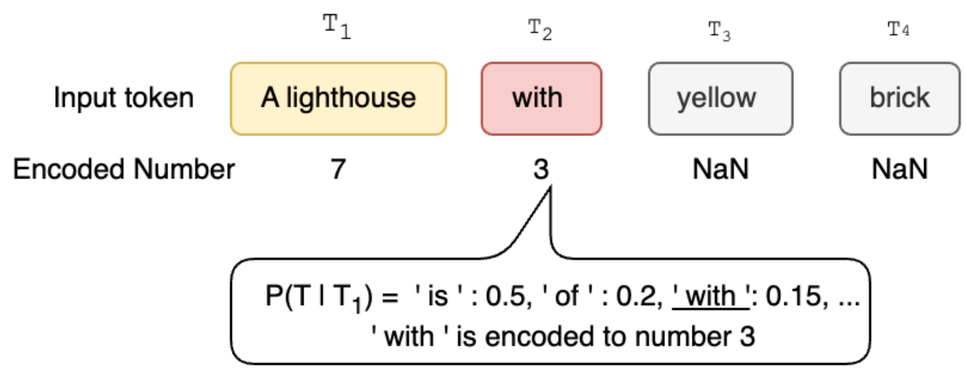
Background

- Learned Image Compression is a technique to design neural network-based non-linear transform and entropy model to compress images

- Its sub-domain, **ultra low-bitrate compression**, targets to less than **0.1 bpp** while keeping good perceptual quality
- Some models utilize **text caption** as a sub-information that captures semantic information (MISC[3], Text & Sketch[4])

- Recently, **Large Language Model** is shown to be effective in text compression and data compression (LLM-ZIP[1], Language Modeling is Compression[2])

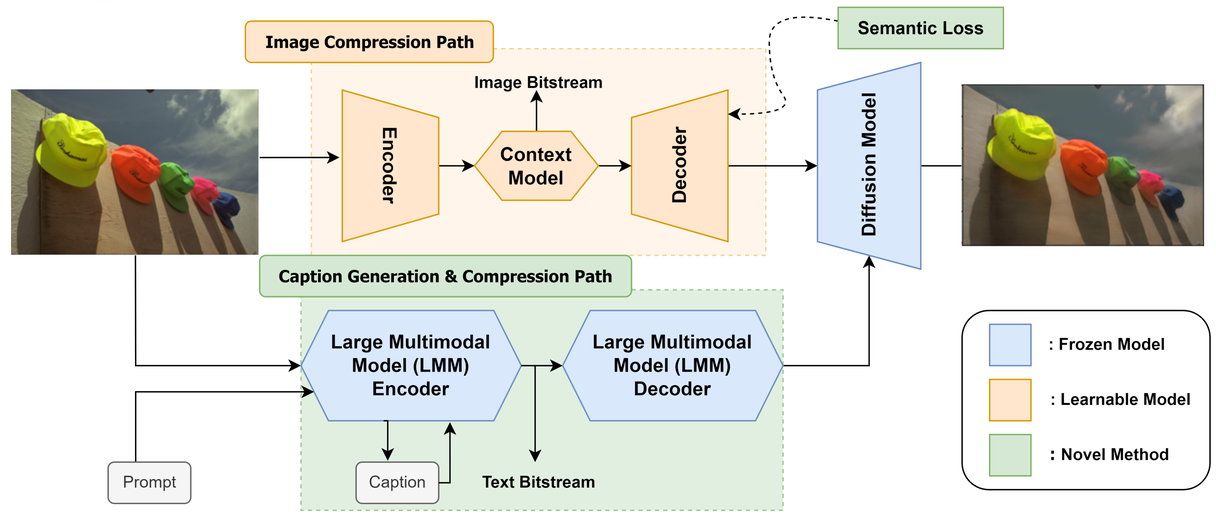


- How can we integrate **LLM based compression** in the workflow of **Learned Image Compression?**

Methodology

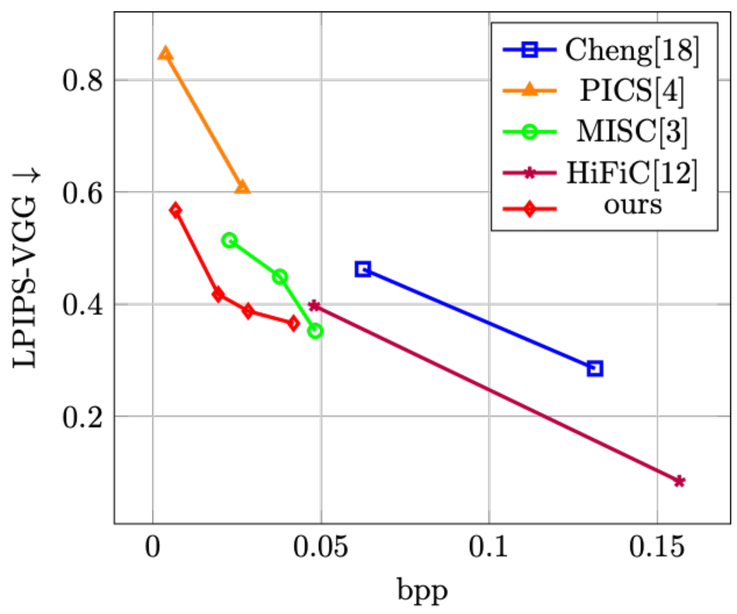
- We generate text caption, and compress it into bitstream **with one large multimodal model**
- Input images are fed to fine-tuned **low-bitrate image compressor**
- Output (distorted) images are then refined with **generative model** conditioned with the caption

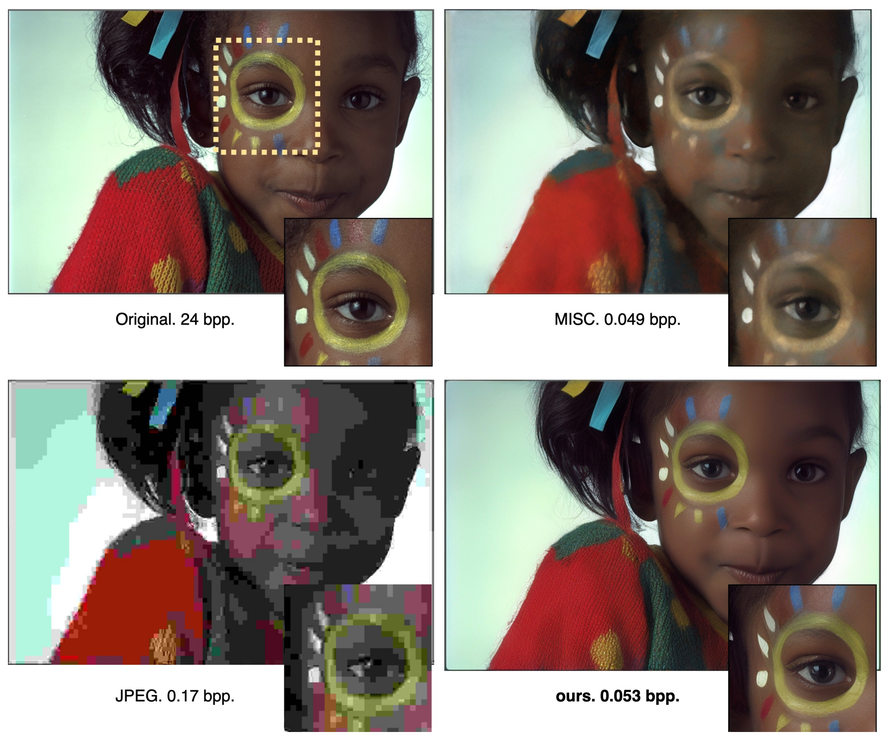
- Our contributions are:
  - We show that **captioning and its compression** can be done in **one LMM**
  - Developed efficient fine-tune methods with **perceptual and semantic loss**



Results & Takeaways

- Our model **achieves more than 65% text compression ratio** and more than **40% bitrate saving** than existing methods (in LPIPS BD rate)
- Example images show our methods eliminate color distortion under ultra low-bitrate (0.053 bpp!)





Code & Demo Available on **GitHub**

[1]C. S. K. Valmeekam, K. Narayanan, D. Kalathil, J.-F. Chamberland,and S. Shakkottai, "LLMZip: Lossless Text Compression using LargeLanguage Models," arXiv preprint arXiv:2306.04050, June 2023.
[2]G. Deletang, A. Ruoss, P.-A. Duquenne, E. Catt, T. Genewein, C. Mat- tern, J. Grau-Moya, L. K. Wenliang, M. Aitchison, L. Orseau, M. Hutter, and J. Veness, "Language modeling is compression," in ICLR, 2024
[3]C. Li, G. Lu, D. Feng, H. Wu, Z. Zhang, X. Liu, G. Zhai, W. Lin, and W. Zhang, "MISC: Ultra-low Bitrate Image Semantic Compression Driven by Large Multimodal Model," arXiv preprint arXiv:2402.16749, no. arXiv:2402.16749, 2024.
[4]E. Lei, Y. B. Uslu, H. Hassani, and S. S. Bidokhti, "Text + sketch: Image compression at ultra low rates," ICML 2023 Workshop Neural Compression, 2023.
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