LYT-NET: LIGHTWEIGHT YUV TRANSFORMER-BASED NETWORK FOR LOW-LIGHT IMAGE ENHANCEMENT

TEAM MEMBERS

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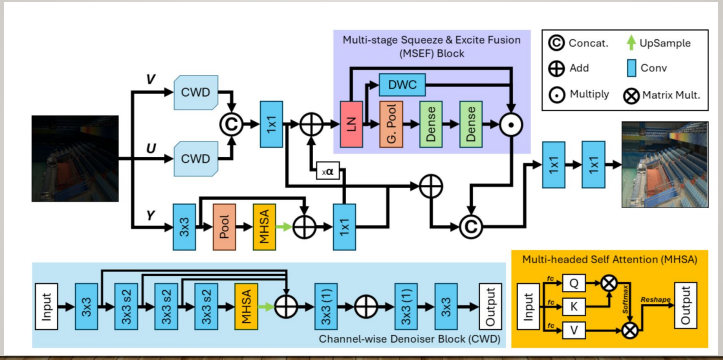
PROBLEM OVERVIEW

- Low-light images often suffer from a **loss of details and contrast**, making them visually unappealing and problematic for computer vision tasks.
- Existing Low-Light Image Enhancement (LLIE) methods often have **high computational complexity** and may compromise the final image quality, particularly in terms of contrast and color fidelity.
- Goal of LYT-Net: Develop a **computationally efficient model** that reduces parameters and improves the clarity and contrast of enhanced images.
- Datasets used
  - LOL v1 - 500 images
  - LOL v2 Real - 789 images
  - LOL v2 Synthetic - 1000 images

PROPOSED SOLUTION



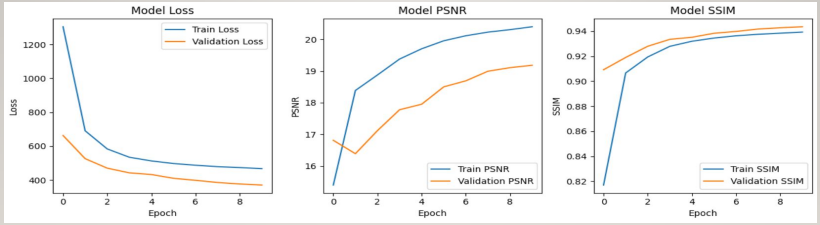
IMPLEMENTATION

- Hybrid loss

$$\mathbf{L} = \mathbf{L}_{\mathrm{S}} + \alpha_1 \mathbf{L}_{\mathrm{Perc}} + \alpha_2 \mathbf{L}_{\mathrm{Hist}} + \alpha_3 \mathbf{L}_{\mathrm{PSNR}} + \alpha_4 \mathbf{L}_{\mathrm{Color}} + \alpha_5 \mathbf{L}_{\mathrm{MS\text{-}SSIM}}$$

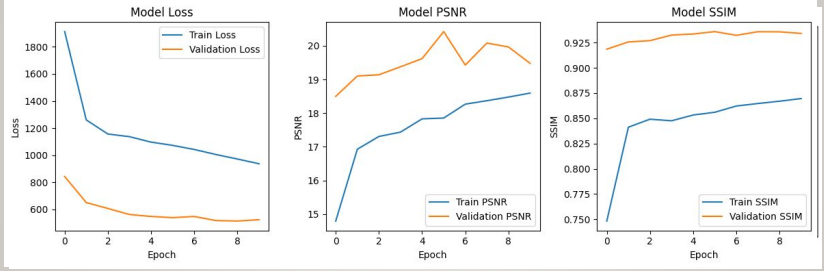
- The model uses an Interpolation-based upsampling method instead of transposed convolutions, reducing the number of parameters while maintaining performance.
- Hyperparameters:
  - Alpha coefficients in the loss function control the contribution of each component in the hybrid loss.
  - Filter/Stride choices in convolution layers and MHSA num of heads were tuned to achieve the best performance.

RESULTS - LOLv1

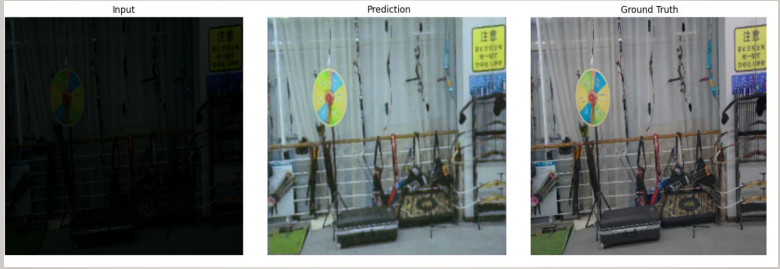


RESULTS - LOLv1 dataset

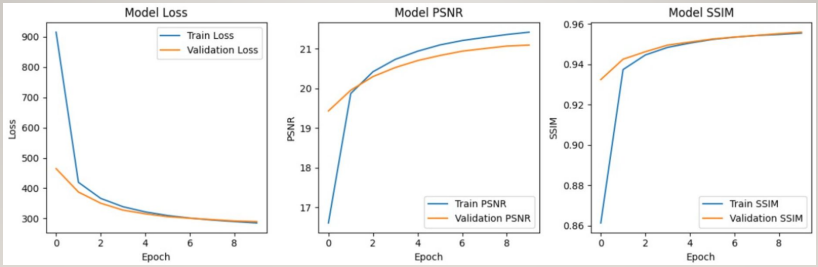
RESULTS - LOLv2 - Real



RESULTS - LOLv2 - Real dataset



RESULTS - LOLv2 - Synthetic



LOL v2 - Synthetic

RESULTS - LOLv2 - Synthetic dataset

RESULTS

Model	Epoch	Param(M)	LOLv1		LOLv2 - Real		LOLv2 - Synthetic	
			PSNR	SSIM	PSNR	SSIM	PSNR	SSIM
Paper	1000	0.045	27.23	0.853	27.80	0.873	29.38	0.940
Ours	10	0.054	19.69	0.785	18.08	0.781	21.10	0.868

CHALLENGES

- Parameter Reduction: LYT-Net's lightweight design was achieved by minimizing parameters through choices like interpolation-based upsampling and careful tuning of filter/stride sizes in convolution layers
- YUV Color Space Split: Early versions of the model produced outputs with inconsistent color dominance. This issue was resolved by fine-tuning the Channel-Wise Denoiser block and adjusting the alpha coefficients in the hybrid loss function to ensure balanced color representation.

Conclusion

- LYT-Net successfully enhances low-light images with significantly fewer parameters compared to other state-of-the-art methods, while achieving comparable or superior performance on standard LLIE benchmarks.
- The use of the YUV color space and lightweight transformer blocks ensures that the model is both computationally efficient and effective at improving image clarity and contrast.
- Future Work: Further optimizations for real-time video enhancement and extending the model for other low-light scenarios such as nighttime video processing.

REFERENCES

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THANK YOU!