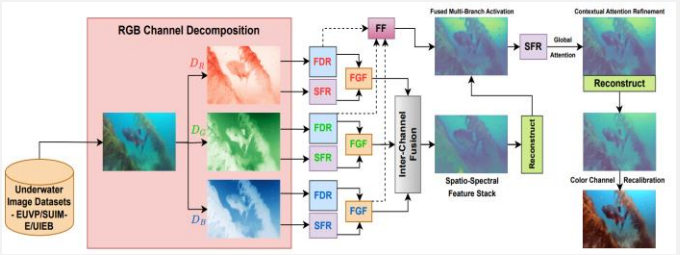
FUSION: Frequency-guided Underwater Spatial Image recOnstructioN

School of Computer Science and Engineering; Center for Human Movement Analytics
Jaskaran Singh Walia*, Shravan Venkatraman*, Pavithra L K

Underwater Image Degradation: The FUSION Approach

Challenge: Underwater images suffer from color casts, blurriness, and low contrast due to wavelength-dependent attenuation.
Current Limitations: Most methods rely only on spatial processing, ignoring uneven degradation across RGB wavelengths [1].



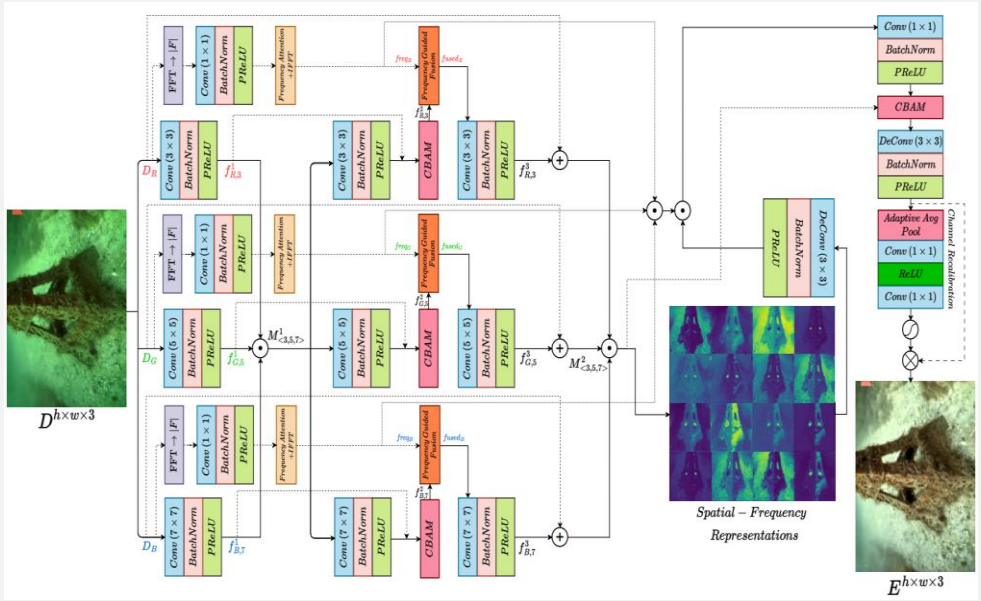
We propose **FUSION**, a dual-domain framework for UIE by jointly leveraging **spatial features**, **frequency cues**, and **channel-specific attenuation** awareness.

FUSION processes each color channel stream independently with λ-aware kernels, while being a lightweight architecture (only **0.28M** params).

Implementation

Our code is publicly available!

The FUSION Architecture

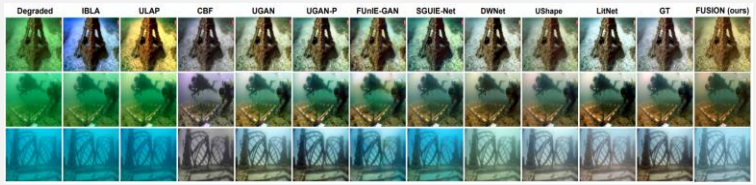


FUSION adopts a dual-domain strategy, independently processing spatial and frequency features, then fusing them through dependent processing, followed by a global color recalibration.

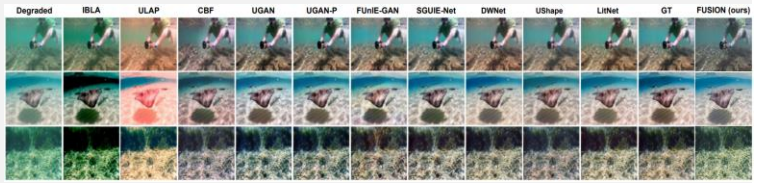
Method	PSNR	SSIM	PSNR	SSIM
	EUVP		UIEB	
UGAN	23.32	0.815	26.551	0.807
UGAN-P	23.55	0.814	26.549	0.805
Lit-Net	23.60	0.863	29.477	0.851
DWNet	23.16	0.843	28.654	0.835
FUSION (Ours)	**23.71**	**0.883**	**28.671**	**0.862**

Qualitative Performance

UIEB Dataset

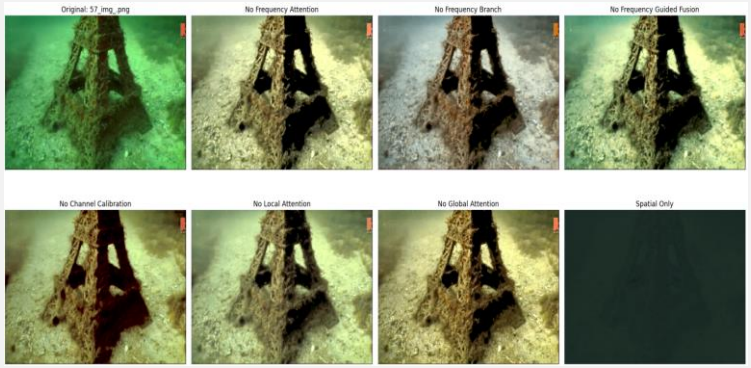


EUVP Dataset



Ablation Studies

We analyze the effect of each component in the proposed architecture through a detailed ablation study.



[1] H. Wang, Z. Li, Y. Zhang, Y. Wang, and J. Li. Learning hybrid dynamic transformers for underwater image superresolution. Frontiers in Marine Science, 11:1389553, 2024. 3