EE367 Project Proposal

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1 Motivation

With the advancement in remote sensing technologies, underwater imaging is becoming a clearer reality for conservation and exploration purposes. In conservation, recording time stamped images of corals give a more holistic view of the rate of ecological damage and habitat destruction global warming is causing. In addition, autonomous underwater vehicles collect vast samples of seabed geological changes and monitor the structure with underwater imaging. Unfortunately, underwater images are prone to color degradation and high noise levels due to wavelength absorption and marine snow (organic particles that cause light to reflect). Therefore, improving methods in color correction and denoising underwater images prove to be hugely beneficial for scientific remote sensing purposes that help us better understand our environment.

2 Related Work

A lot of efforts seek to combine classical denoising algorithms with neural lets like U-net for sharpening. For example, [Wu+22] uses a nonlocal means for denoising with a Gaussian weighted spatial distance to help measure similarity in similar patches. They then use a U-net to color correct with enhanced feature extraction. Other research emphasizes on real-time processing such as [TD05] using a Markov Random Field to distinguish the relationship between color depleted images. Moreover, [Li+17] uses a more physics-based approach for color correction as it seeks to restore color depending on their wavelength, since higher wavelengths are attenuated more in shallower depths. Lastly, [Men+22] uses the fact that color channels distort dis-proportionally underwater and uses information from other channels to better reconstruct the images. They also employ a DCP-based method for dehazing and color correction.

3 Project Overview

This project aims to focus on color correction with attempts at marine snow/particle removal and additional denoising. If time permits, it will aim to address the

dehazing issue. I will mainly explore classical methods proposed by relevant work authors and compare their efficiency against one another. A learning-based method will be attempted too, but I don't expect high performance since data is scarce for exploratory deep sea imaging. I'll start with displaying their methods and using it on the database provided by [Li+20]. I'll then implement the methods and segmenting and concatenating the research work to see if there are improvements. I'll also explore other denoising methods (ADMM and HQS) that aren't specific to underwater imaging to evaluate their performance via psnr comparison or other metrics. Both qualitative and quantitative comparison will be used.

4 Milestones and Timeline

Week 8: Review, read, and understand relevant works
- Decipher which algorithms are implementable, ask mentors if there are confusions in the paper vs. practice
Week 9: Implement the algorithms and evaluate their performances
- Talk with mentors on results, issues, debugging
Week 10: Write paper and setup presentation
- Talk with mentor on which results to include if the scope is tailored down

References

[TD05] Luz A. Torres-Méndez and Gregory Dudek. "Color Correction of Underwater Images for Aquatic Robot Inspection". In: *Energy Minimization Methods in Computer Vision and Pattern Recognition*. Ed. by Anand Rangarajan, Baba Vemuri, and Alan L. Yuille. Berlin, Heidelberg: Springer Berlin Heidelberg, 2005, pp. 60–73. ISBN: 978-3-540-32098-2.

[Li+17] Chongyi Li et al. "A hybrid method for underwater image correction". In: *Pattern Recognition Letters* 94 (2017), pp. 62–67. ISSN: 0167-8655. DOI: https://doi.org/10.1016/j.patrec.2017.05.023. URL: https://www.sciencedirect.com/science/article/pii/S016786551730171X.

[Li+20] Chongyi Li et al. "An Underwater Image Enhancement Benchmark Dataset and Beyond". In: *IEEE Transactions on Image Processing* 29 (2020), pp. 4376–4389. DOI: 10.1109/TIP.2019.2955241.

[Men+22] Haiyang Meng et al. "A hybrid algorithm for underwater image restoration based on color correction and image sharpening". In: *Multimedia Systems* 28.6 (2022), pp. 1975–1985. DOI: 10.1007/s00530-020-00693-2. URL: https://doi.org/10.1007/s00530-020-00693-2.

[Wu+22] Zeju Wu et al. “Underwater Image Enhancement Based on Color Correction and Detail Enhancement”. In: *Journal of Marine Science and Engineering* 10.10 (2022). ISSN: 2077-1312. DOI: 10.3390/jmse10101513. URL: https://www.mdpi.com/2077-1312/10/10/1513.