SenSIP
Sensor, Signal and Information Processing Center

Ira A. Fulton Schools of Engineering
ARIZONA STATE UNIVERSITY

Dehazing Underwater Images to Detect Marine Organism Events in Turbid Environments

Presented by Alejandro Hinojos

Mentored by Seckin Demir & Sule Ozev

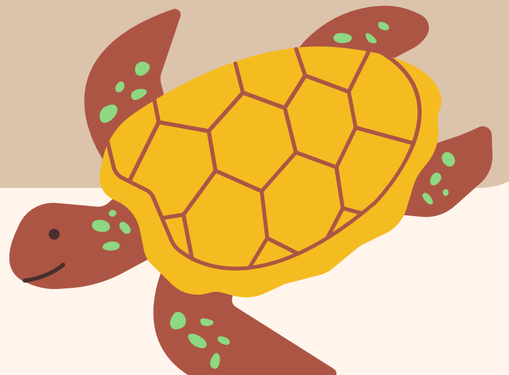
NSF Research Experience for TEACHERS (RET)

NSF Award 1953745

AGUA FRIA HIGH SCHOOL

Background

- A need to quantify the behavior of bycatch species
- Suspended particles in water create hazy and distorted images
- Depth perception and Object recognition is difficult
- Cleaning hazy underwater images into useful formats
- Dehazing + color-restoration + depth estimations are used to quantify underwater motions



Research Objectives

- The current research effort combines state-of-the-art haze removal algorithms and underwater structure representation networks in image processing machine learning technology
- Used to enhance image clarity and object information

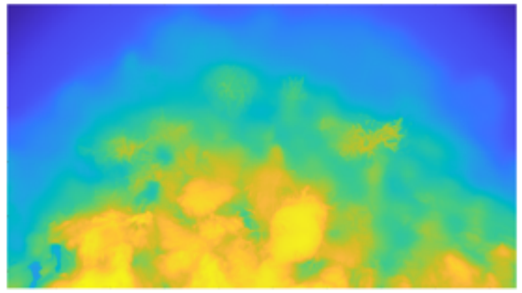
Multiple algorithms will be used in parallel to determine the most effective methods to restore underwater image quality

My focus was on deploying a single method

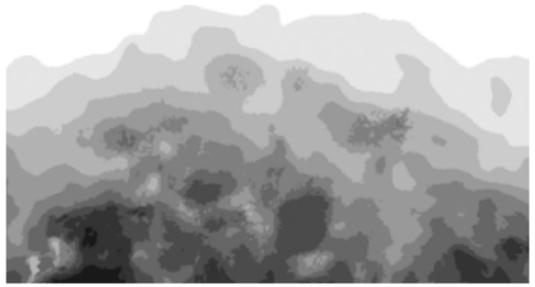
This focused effort is part of a larger effort to combine these methods & apply that to the even larger lighted bycatch reduction technology (LBRT)

Research

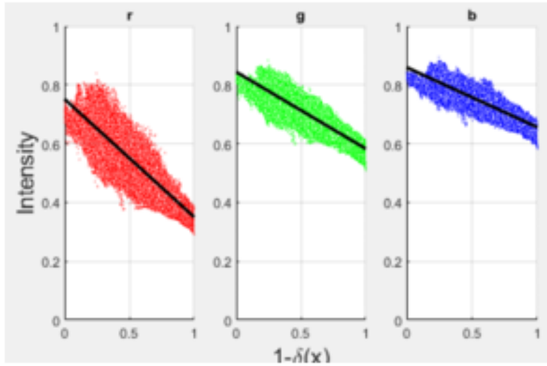
- **Single-image dehazing techniques for above-sea images**
- **Depth estimation introduces errors and is unsuitable for underwater images**
- **light attenuation varies based on wavelength**
- **Requires distinct transmission maps for each color channel**



a) Light Attenuation Map δ_R



b) Evenly Spaced Mask of δ_R for Depth Clustering



c) Linear Fit of the Dark RGB Triplets to Light Attenuation Map

d) Estimated Backscatter Map B_c

$$I_c = J_c(a + b\hat{\delta}_c) + B_c, c \in \{R, G, B\}$$

e) Output image equation compensated for distortion

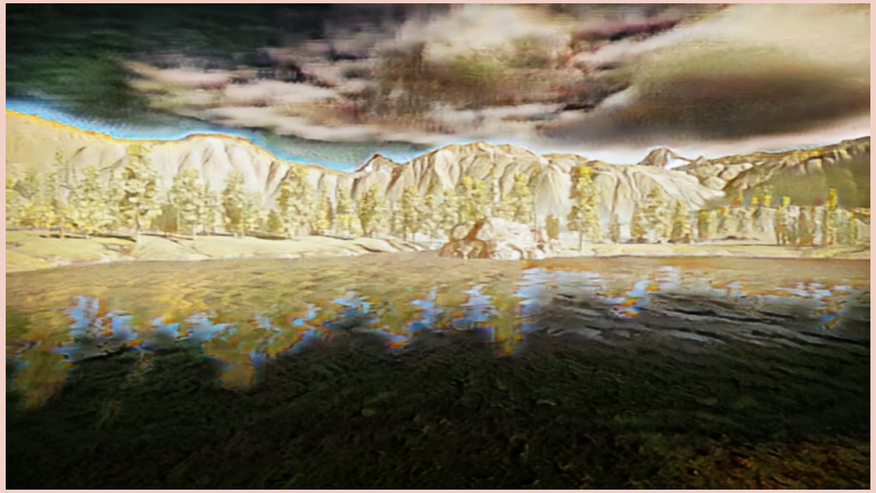
Focused Research

- Effective method for filtering dense and non-uniform distortions caused by fog, haze, and dust
- Utilizes a structure representation network combined with uncertainty feedback learning
- Feature representations are extracted using trained Vision Transformer (DINO-ViT)
- Uncertainty maps generated through feedback learning identify densely hazed areas for iterative fog refinement, combined with greyscale versions of input images for better handling of varying light colors

a) Original Images (I_h) b) Proposed Method Results

Results

- Ruled out the suggested method provided by mentors due to the convoluted coding structure
- Enabled the algorithm to be run on both GPU and CPU, for computers with lower-grade graphics cards



Before Dehazing

After Dehazing

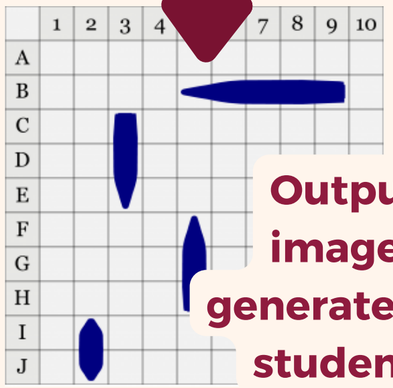
- The results were low quality
- Method will still be reported

High School Computer Science Lesson

- Group "Battleship" game between teams
- Inquiry Lesson On Image Processing

- Students will be able to understand Python inputs and outputs in order to dehaze premade images

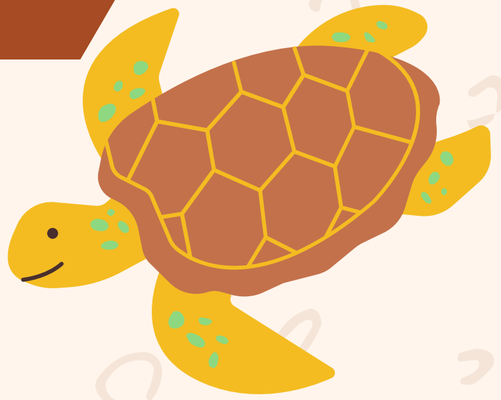
- Students will be provided premade images and Python code
- They will use knowledge of inputs and outputs to dehaze their own images



Real World Connections

Engineering: Software, Image Processing, AI, Sensors, Medical, Geo

Enviornmental Science: Inspiring Conservation through Technology

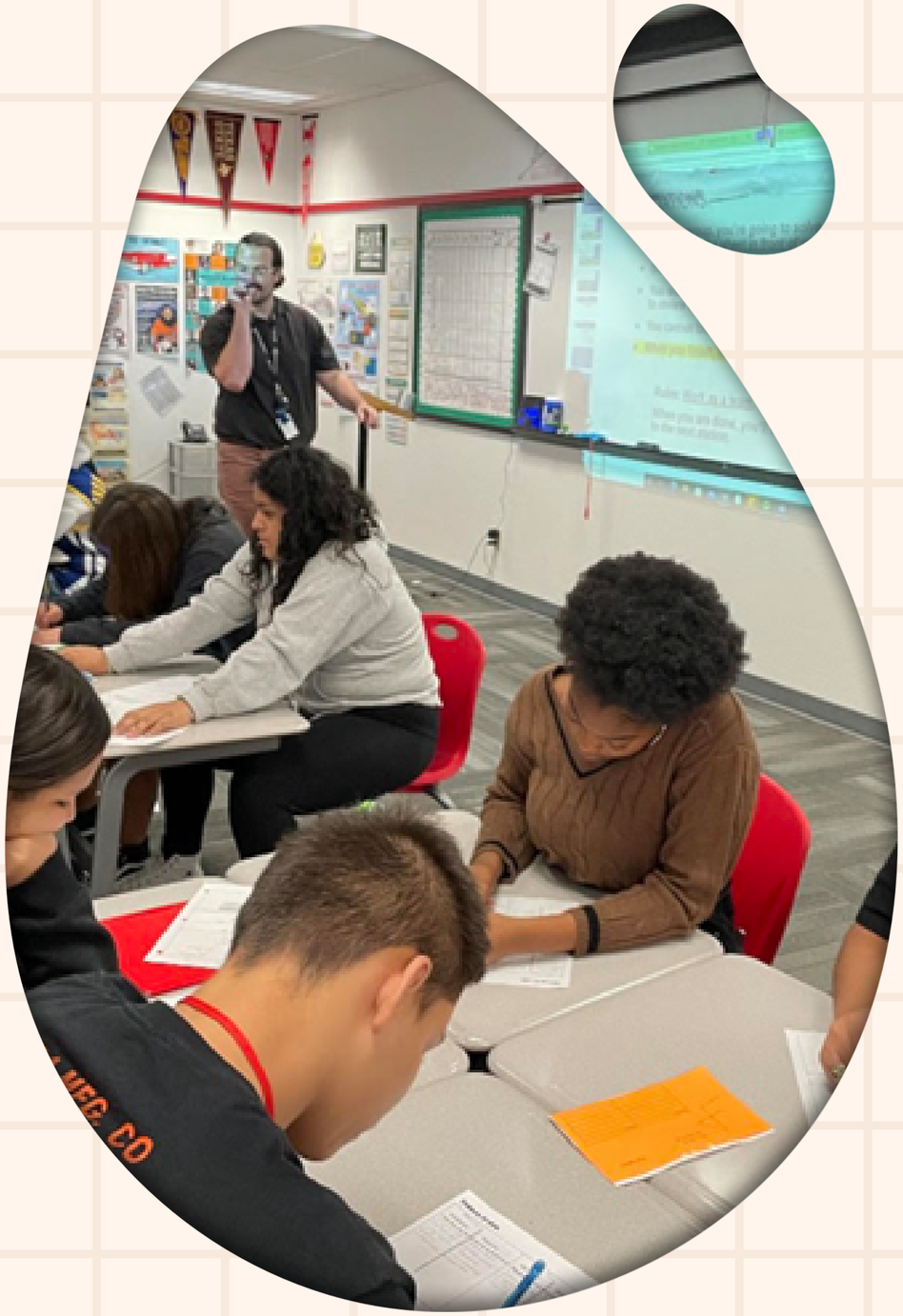


Conclusion

Research: Training Model with relevant images OR new Algorithms

Self-Assessment: Python Experience, Open-Source, Academic Research

Classroom: Furthering AI and Software Understanding



SenSIP

Sensor, Signal and Information Processing Center

THANK YOU SO MUCH!

Alejandro Hinojos | ajhinoj3@asu.edu

https://sensip.engineering.asu.edu/ret/