Knight School of Computing and Information Sciences

Spring 2024 Senior Design Project

Using AI with a Low-Cost Camera to Detect Harmful Algae in Natural Water

Students: Kiran Brahmatewari, Cristian Cruz, Justin Prater
Mentor: Dr. Antao Chen, Beckman Coulter Staff Engineer
Instructor/Faculty: Dr. Seyedmasoud Sadjadi, Florida International University

PROBLEM

- Blue-green algae can be extremely harmful to the environment when they undergo explosive population growth (i.e., algal bloom)
- These blooms kill fish by depriving them of oxygen and can create toxins that are harmful to both wildlife and humans
- According to the EPA, harmful algal blooms cost the US almost $1 billion/year
- This project aims to simplify and expedite the detection of harmful algae within a given sample of water by leveraging state-of-the-art AI

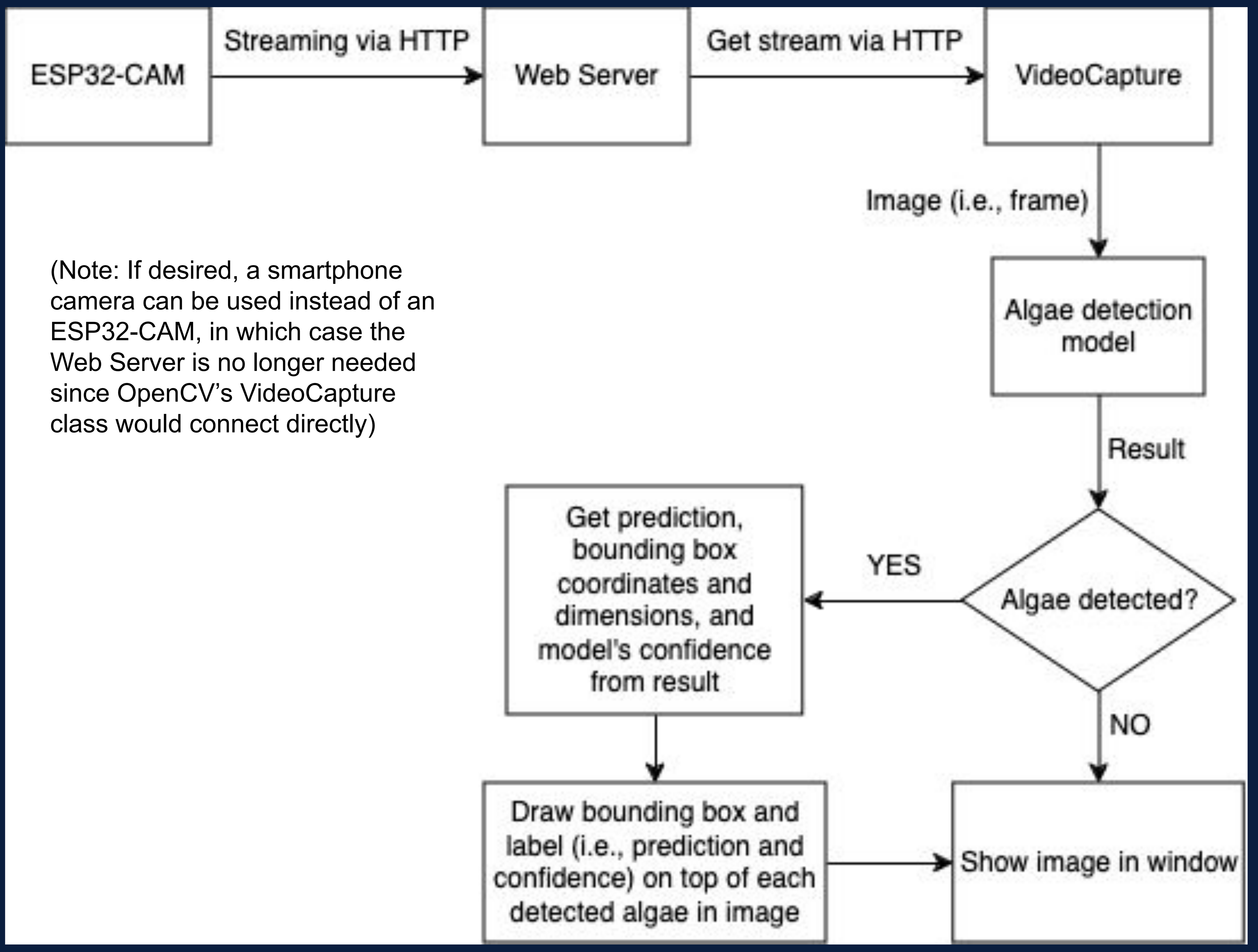
SUMMARY

- Harmful algal blooms (caused by blue-green algae) have a detrimental impact on human health, aquatic ecosystems, and local economies
- By training a convolutional neural network on a large dataset comprised of closterium, nitzschia, microcystis, oscillatoria, and non-algae, users can quickly, safely, and easily detect and classify harmful algae within water in real-time with an ESP32-CAM (or, alternatively, smartphone), microscope, and computer
- Future work will focus on increasing the model's accuracy by adding more images to the dataset, improving the model's versatility by incorporating a larger variety of algae in the dataset, using a heatsink to prevent the ESP32-CAM from overheating, updating the microscope's 3D printed lens attachment to accommodate a wider range of cameras, and more

REFERENCES

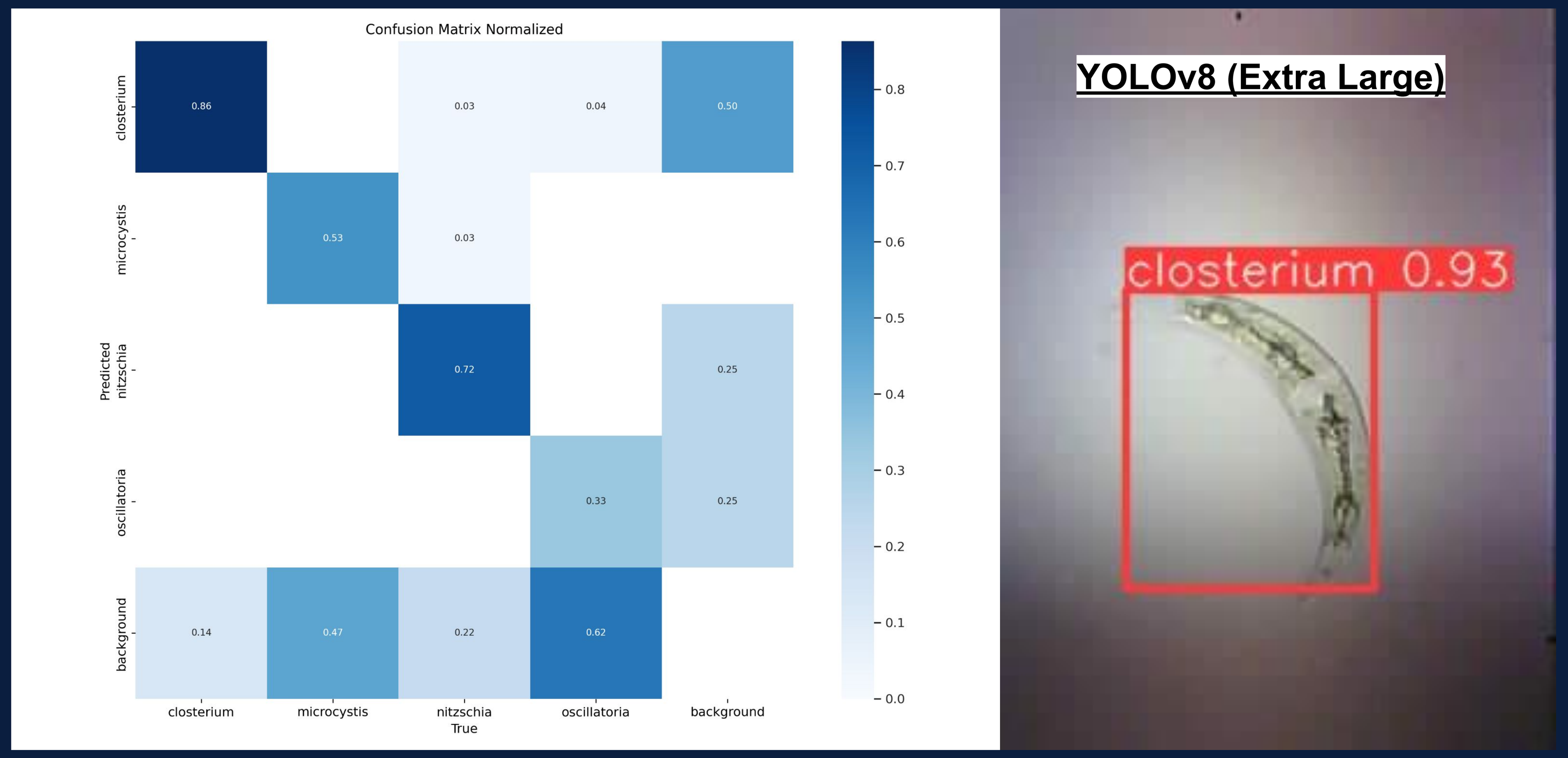
- https://github.com/lynkos/algae-detection
- https://github.com/rzeldent/esp32cam-rtsp/tree/develop
- https://www.usgs.gov/news/national-news-release/usgs-finds-28-types-cyanobacteria-florida-algal-bloom

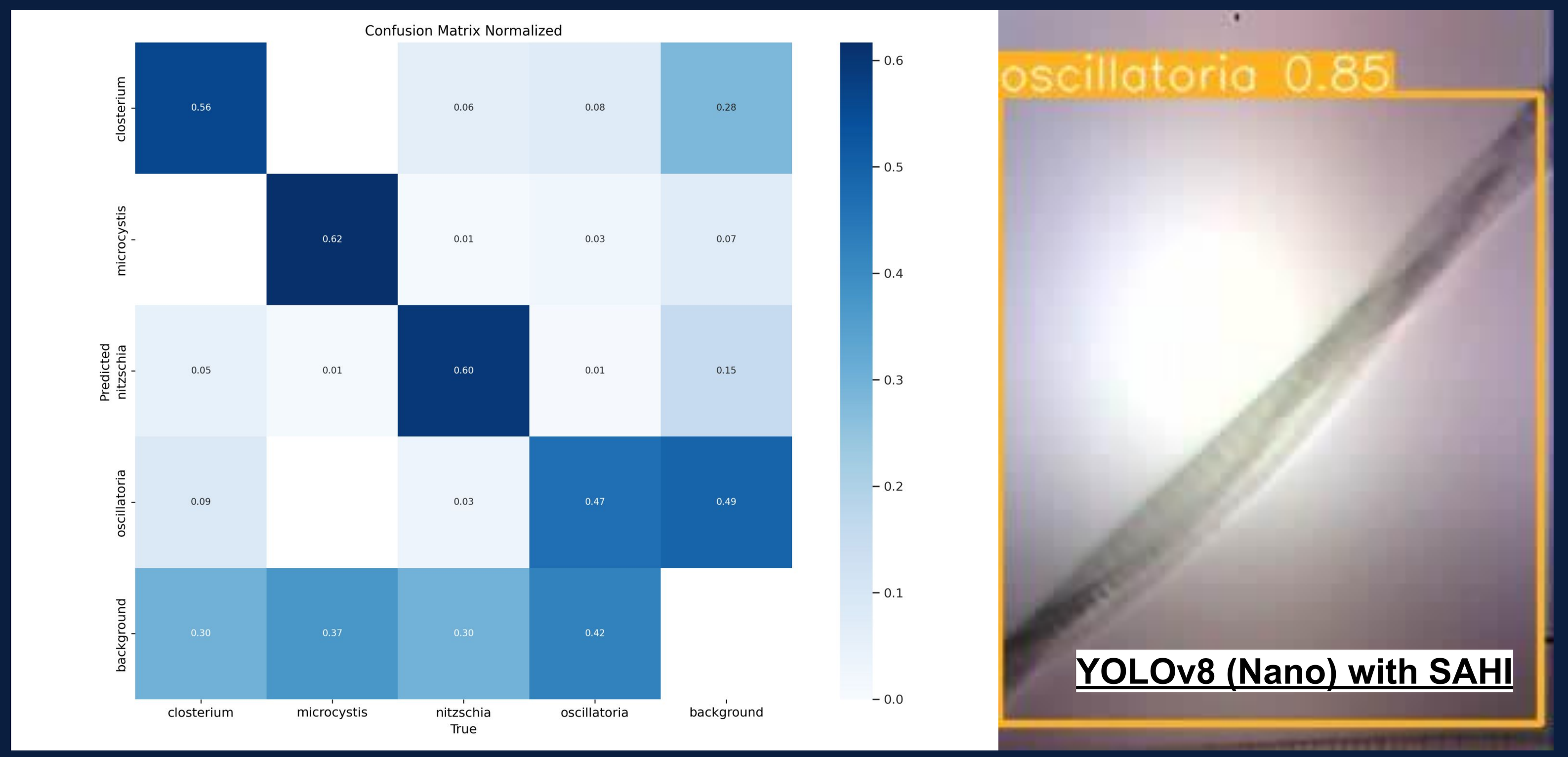
SYSTEM DESIGN

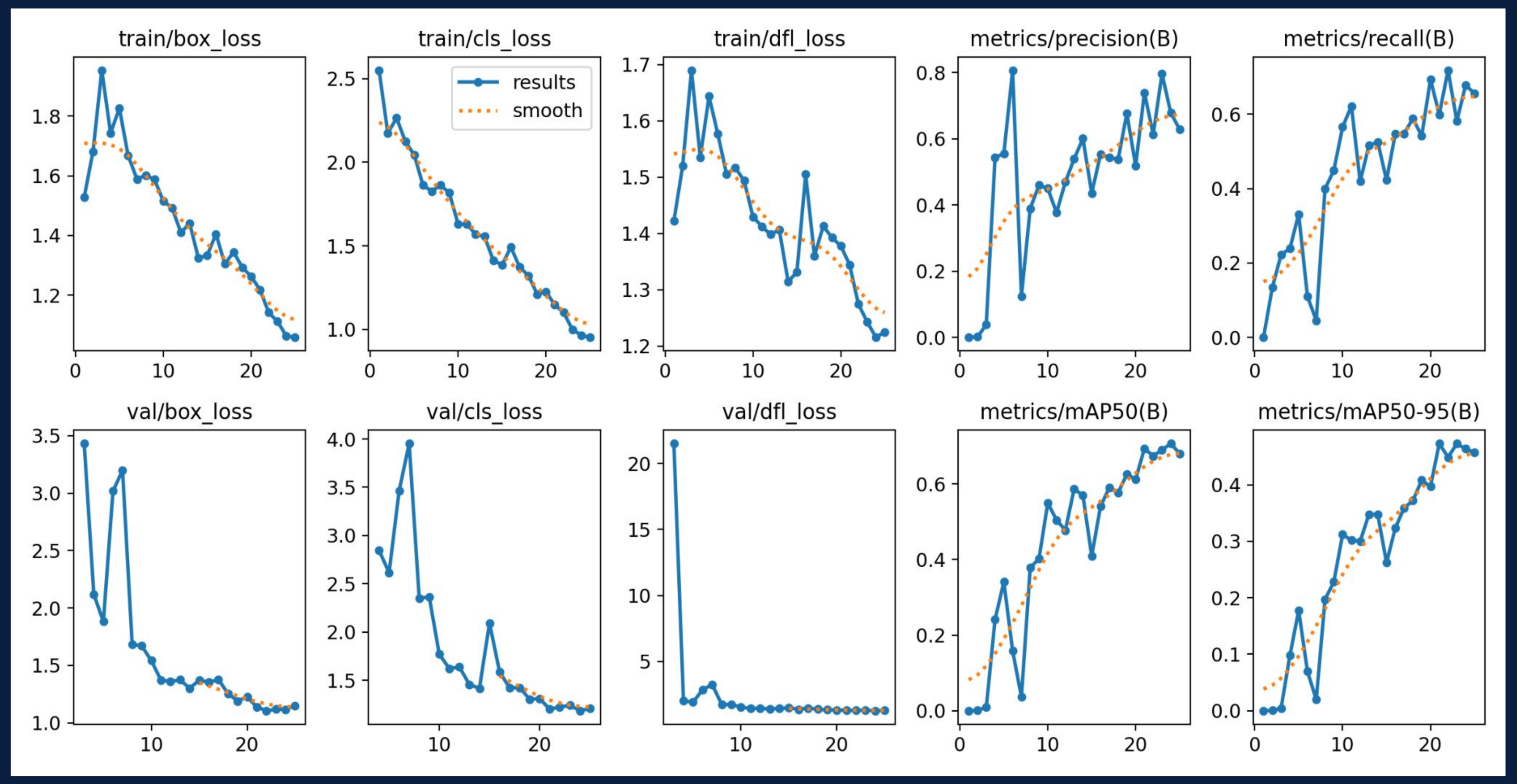


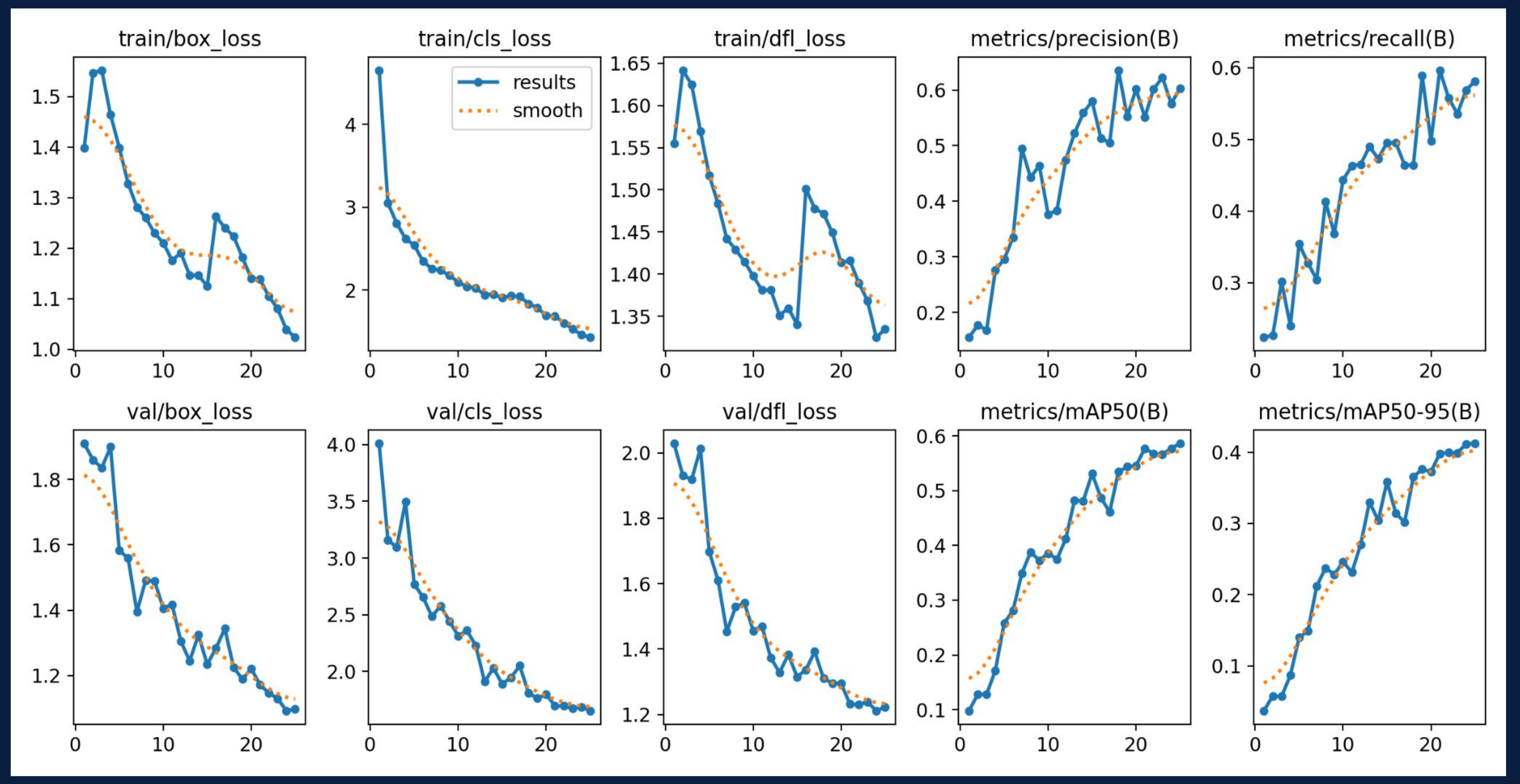
CURRENT SYSTEM

VERIFICATION









IMPLEMENTATION

Hardware:
- ESP32-CAM AI Thinker
- Nikon Microscope with 3D printed lens attachment and illuminator
- MacBook Pro M3 Max with 64 GB memory, 2 TB storage, 16 core CPU, 16 core NPU, 40 core GPU, arm64 architecture

Software:
- Platformio, Espressif framework, Arduino framework
- Roboflow, Ultralytics YOLOv8, OpenCV, Pytorch, Colab
- Python, C++, HTML, Jupyter, Anaconda, Visual Studio Code

Dataset:
- Around 2000 images (downscaled to 256 x 256) of non-algae and 4 types of algae, though only a subset was used for training
- Training, Validation, Testing Split: 0.88, 0.08, 0.04

Classes:
- Closterium
- Nitzschia
- Microcystis
- Oscillatoria
- Non-algae

Model Architecture:
- YOLOv8 (Extra Large)
- YOLOv8 (Nano) with SAHI

ACKNOWLEDGEMENT

The material presented in this poster is based upon the work supported by Dr. Antao Chen. We thank Dr. Chen for his assistance and mentorship that we received throughout the senior design project.

FLORIDA INTERNATIONAL UNIVERSITY

Engineering & Computing