FLORIDA INTERNATIONAL UNIVERSITY

FIU | Knight Foundation School of Computing and Information Sciences

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

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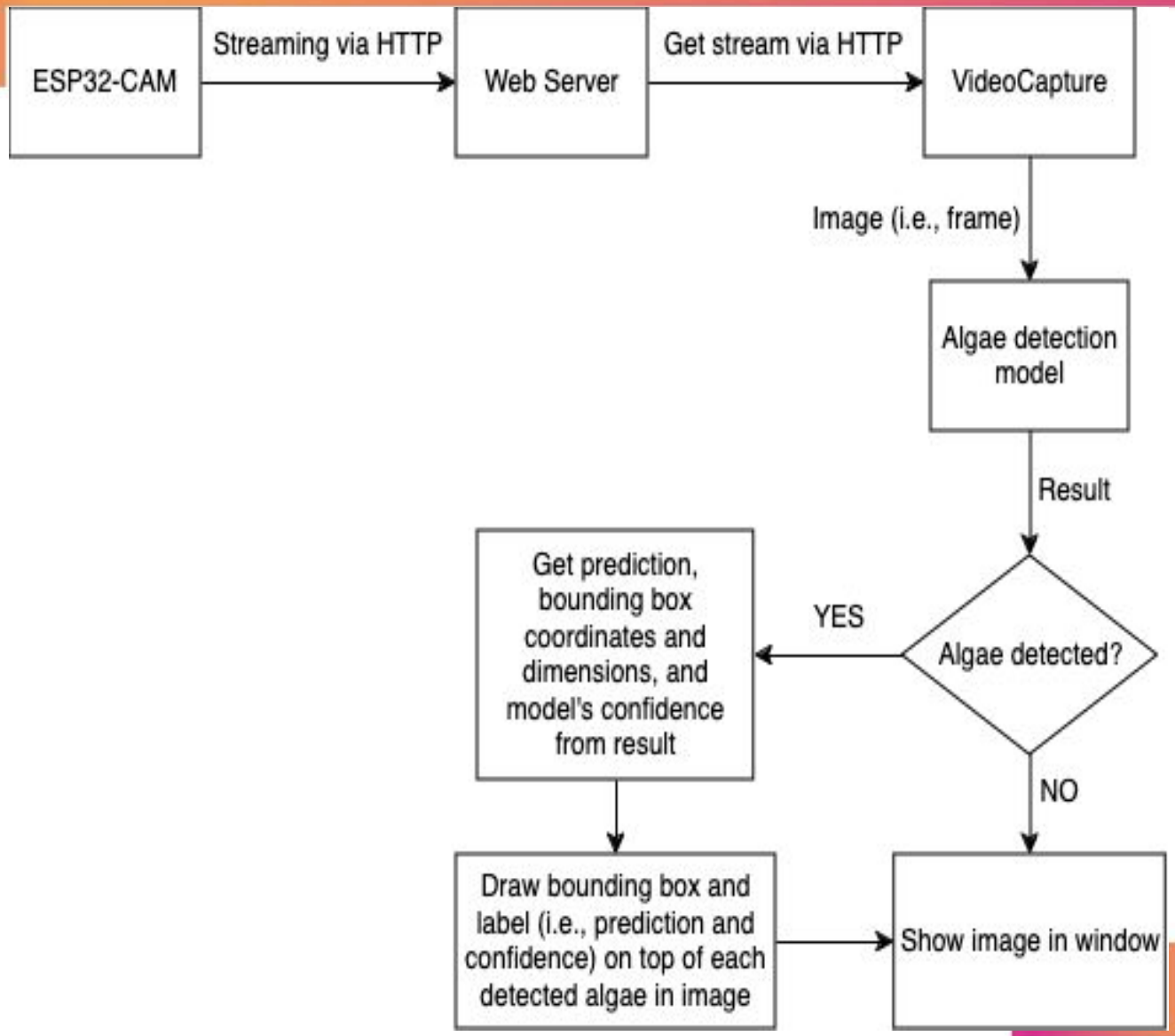
Motivation

- Harmful algae blooms can be detrimental to the environment when undergoing uncontrolled population growth
- These blooms deplete environments of oxygen, killing fish, harming humans, and disrupting local economies
- With an easier means to locate and detect some of these classes of algae, it would alleviate the burden of classifying algae when trying to search for the appropriate solution

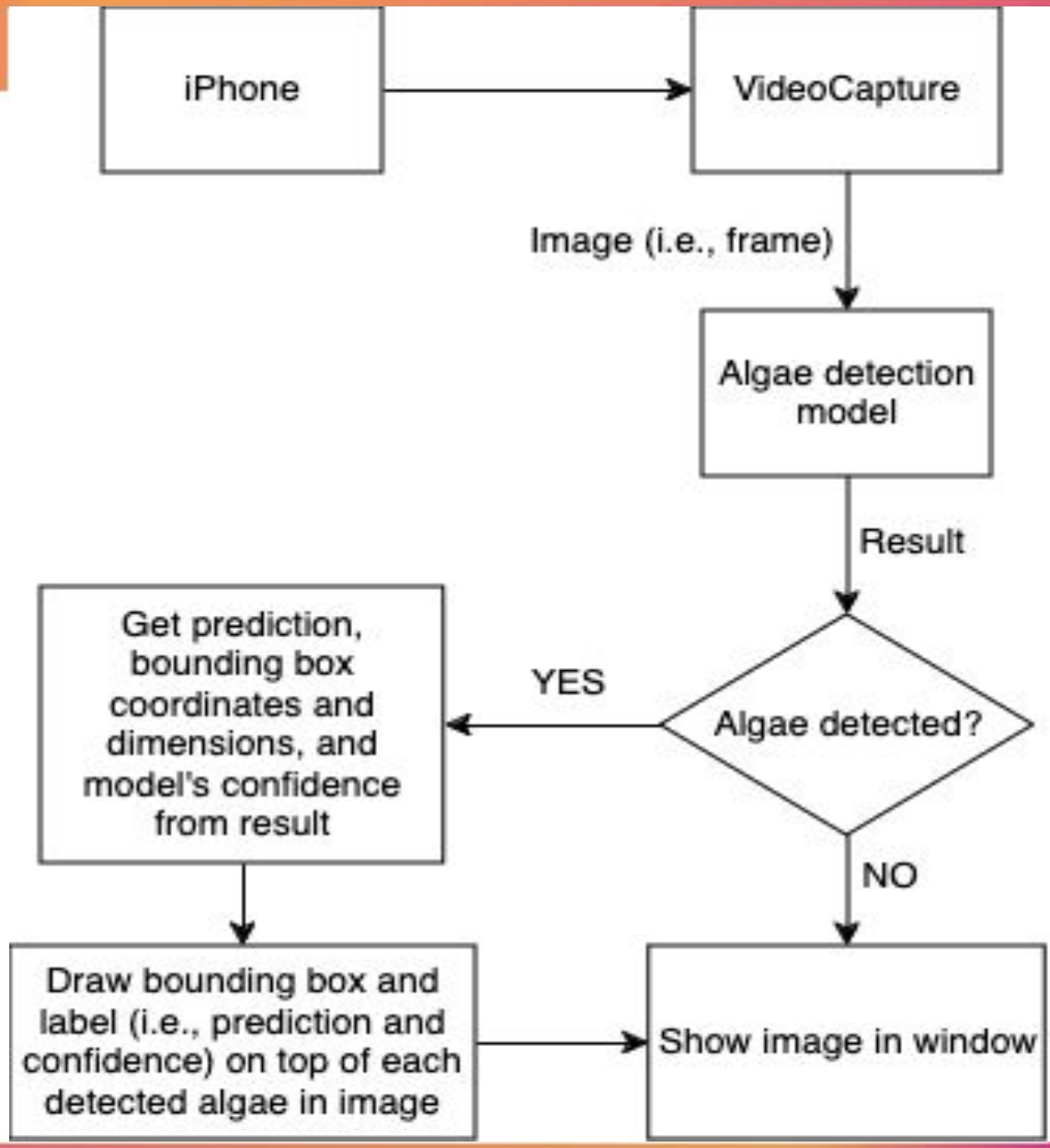
Solution

- Using the inexpensive and accessible ESP32-CAM, a microscope, and our product, different types of algal blooms can be detected rapidly and dealt with accordingly
- The AI models were trained using the YOLOv8 and PyTorch framework, and implemented using Python

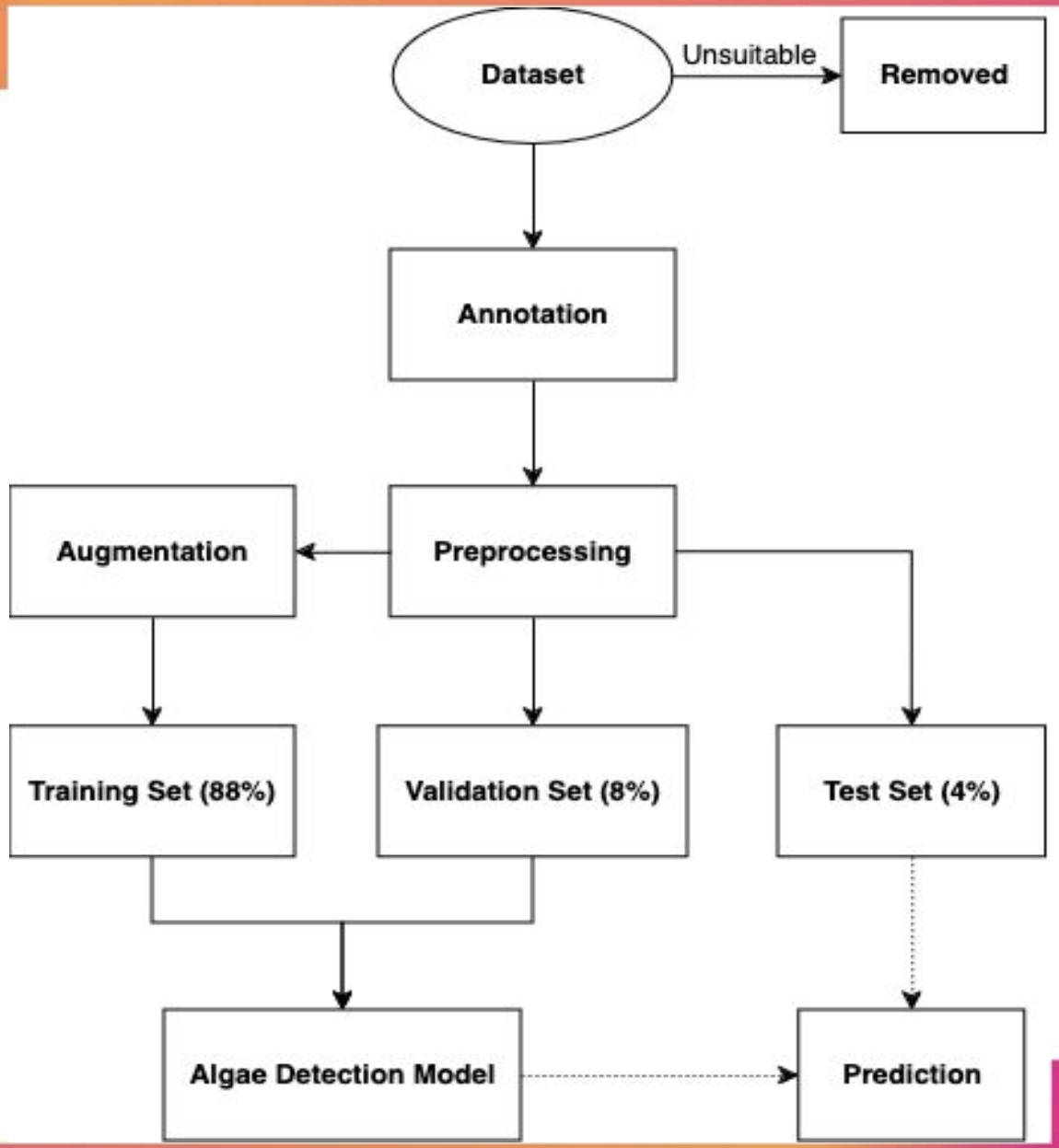
Solution Design: src/detection/esp32.py



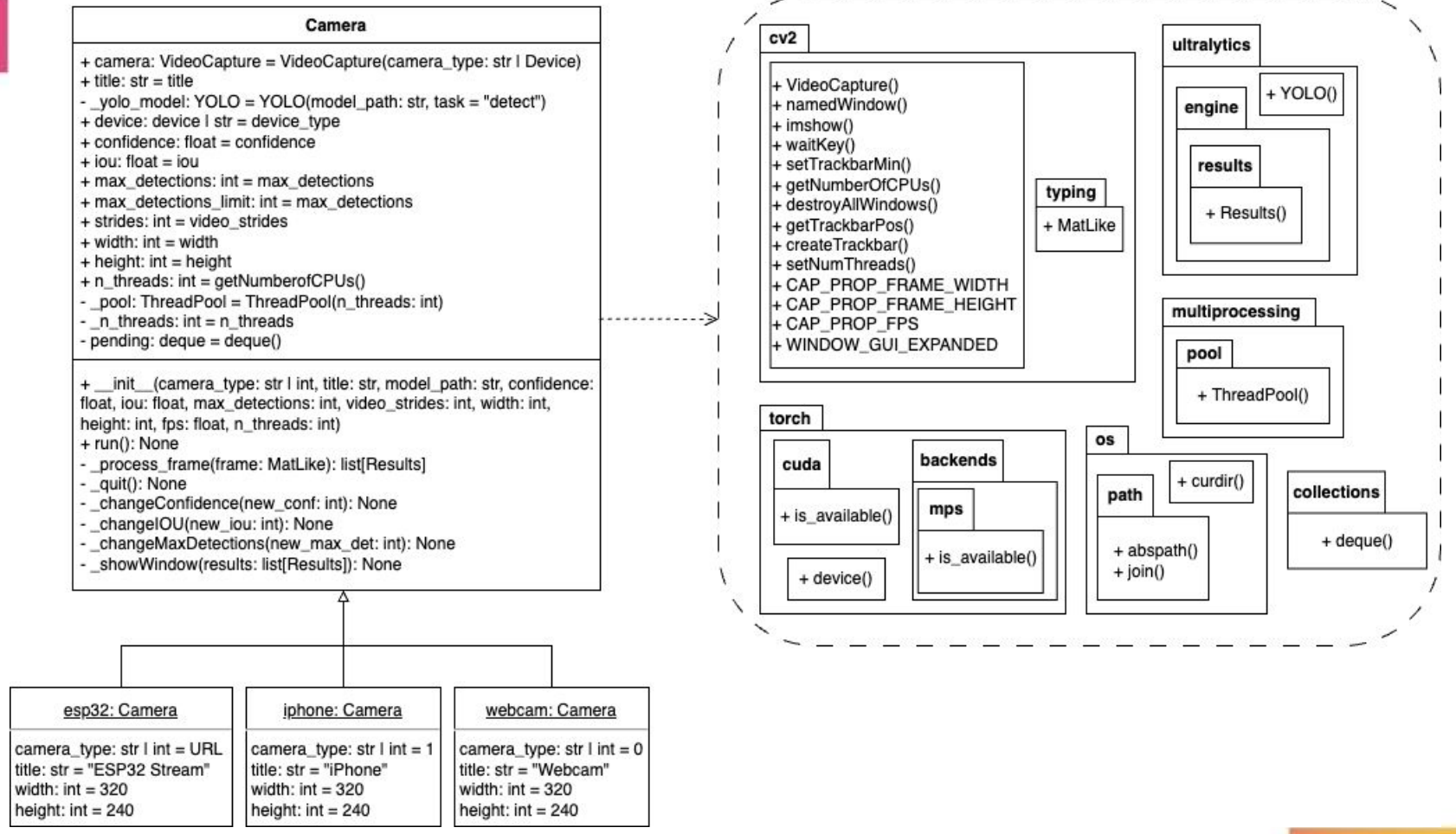
Solution Design: src/detection/iphone.py



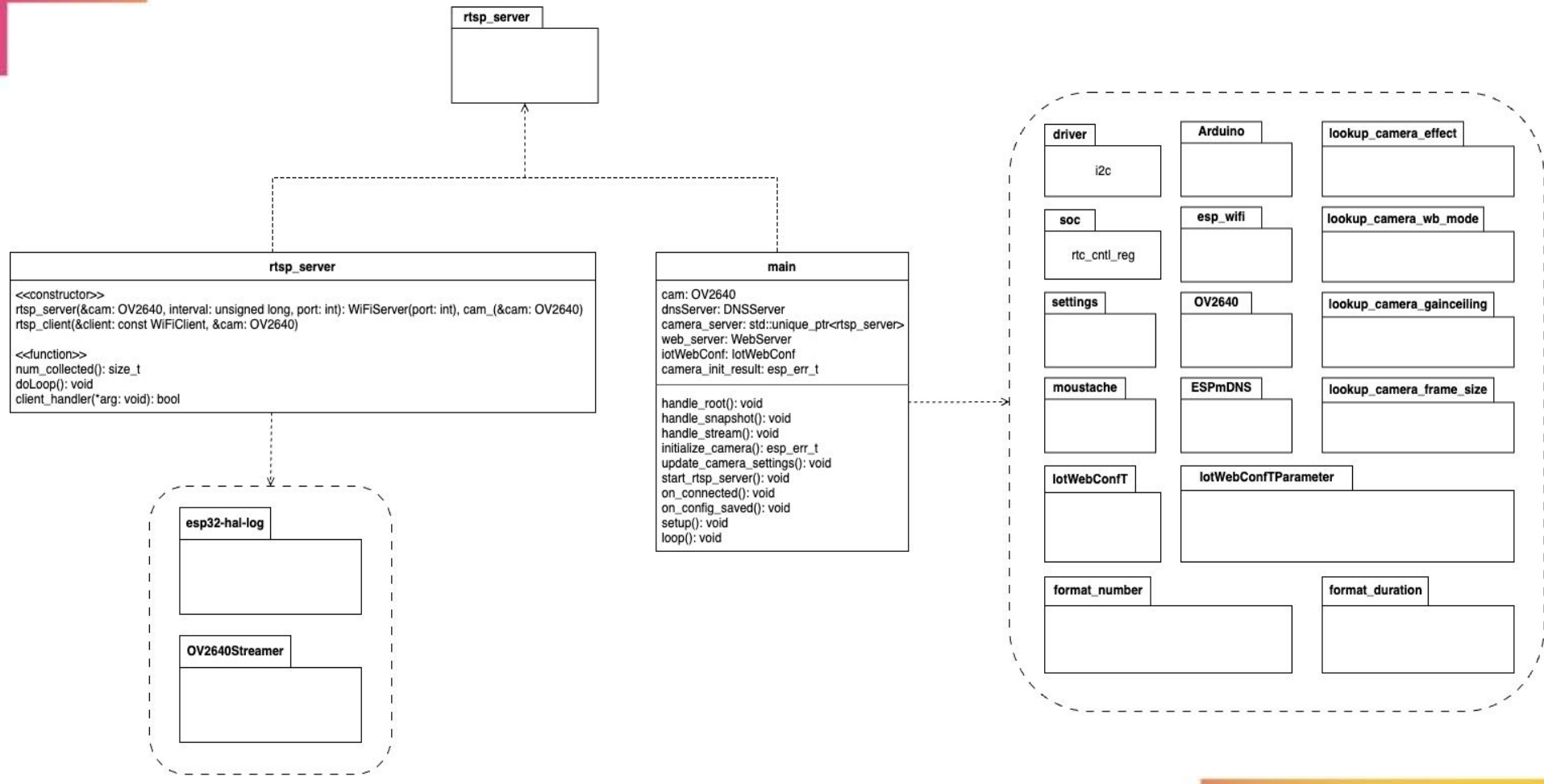
Solution Flowchart: Dataset



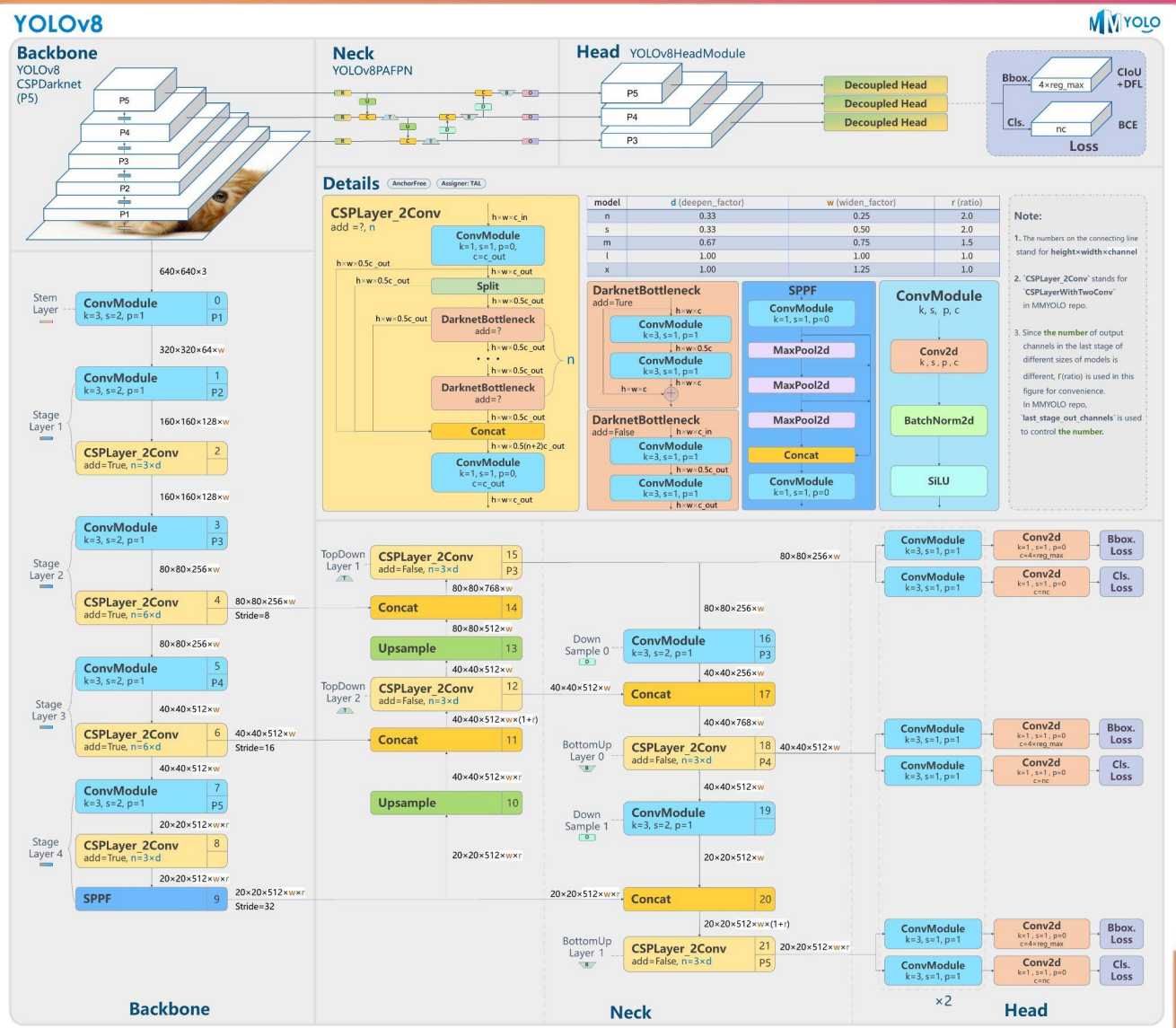
Solution UML: src/detection



Solution UML: src/streaming



Solution Architecture: YOLOv8



Dataset

- Images
  - Around 2000
  - Downscaled to 240 × 320
  - Subset used for training
- Classes
  - Closterium
  - Nitzschia
  - Microcystis
  - Oscillatoria
  - Non Algae

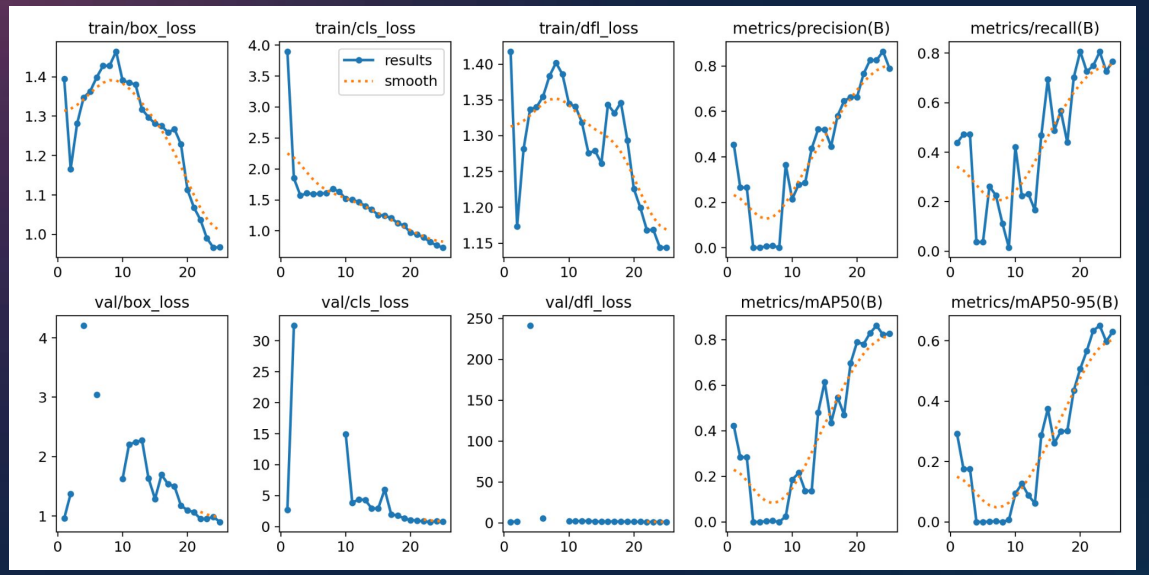
Figure 1. Image of Closterium

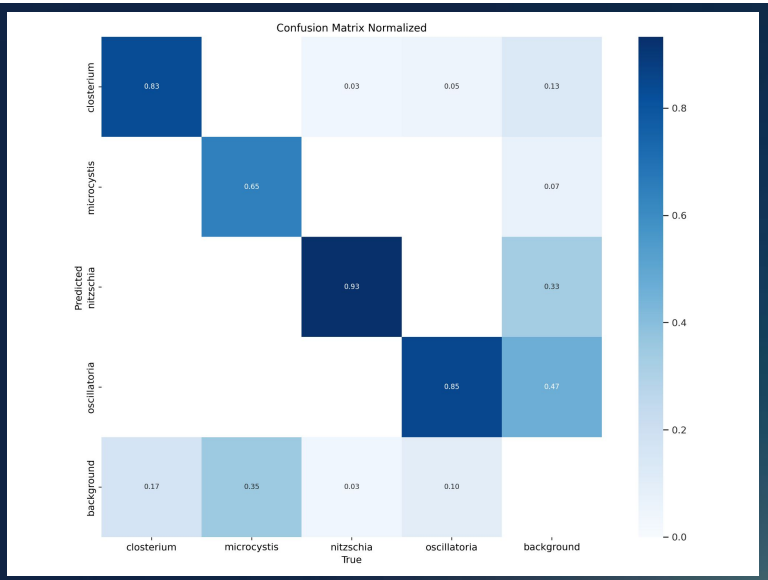
Figure 2. Image of Microcystis

Model Development: YOLOv8x

- Split
  - Training: 0.88
  - Validation: 0.08
  - Testing: 0.04
- Epochs: 25
- Optimizer: Adam

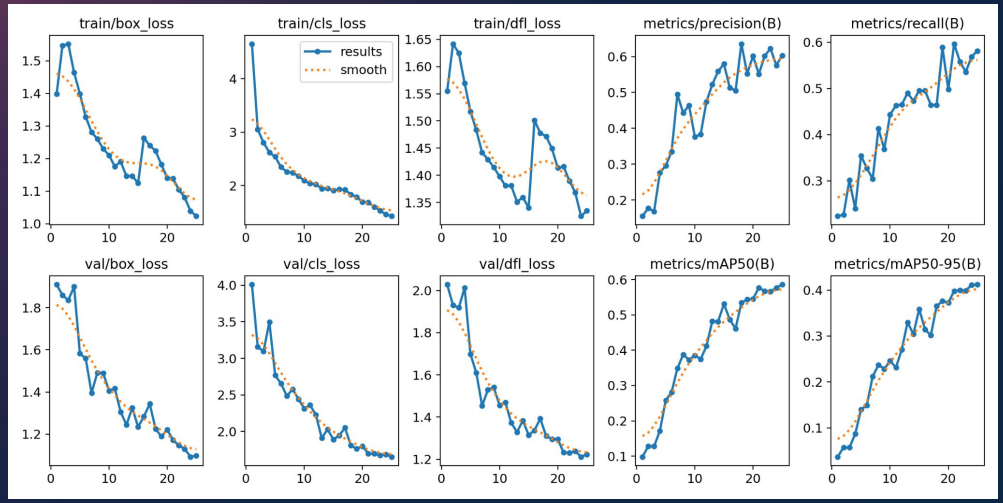
Note: This is the most recently trained version (i.e., v2.0)

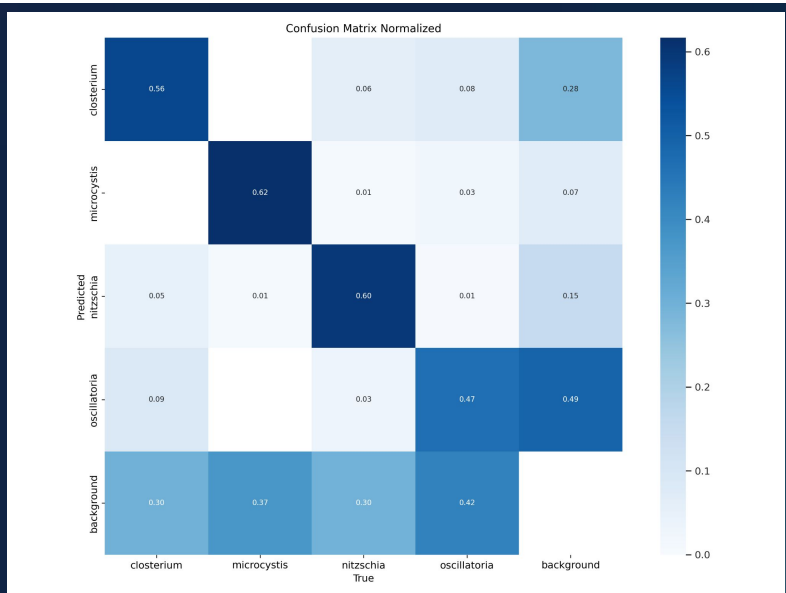




Model Development: YOLOv8n + SAHI

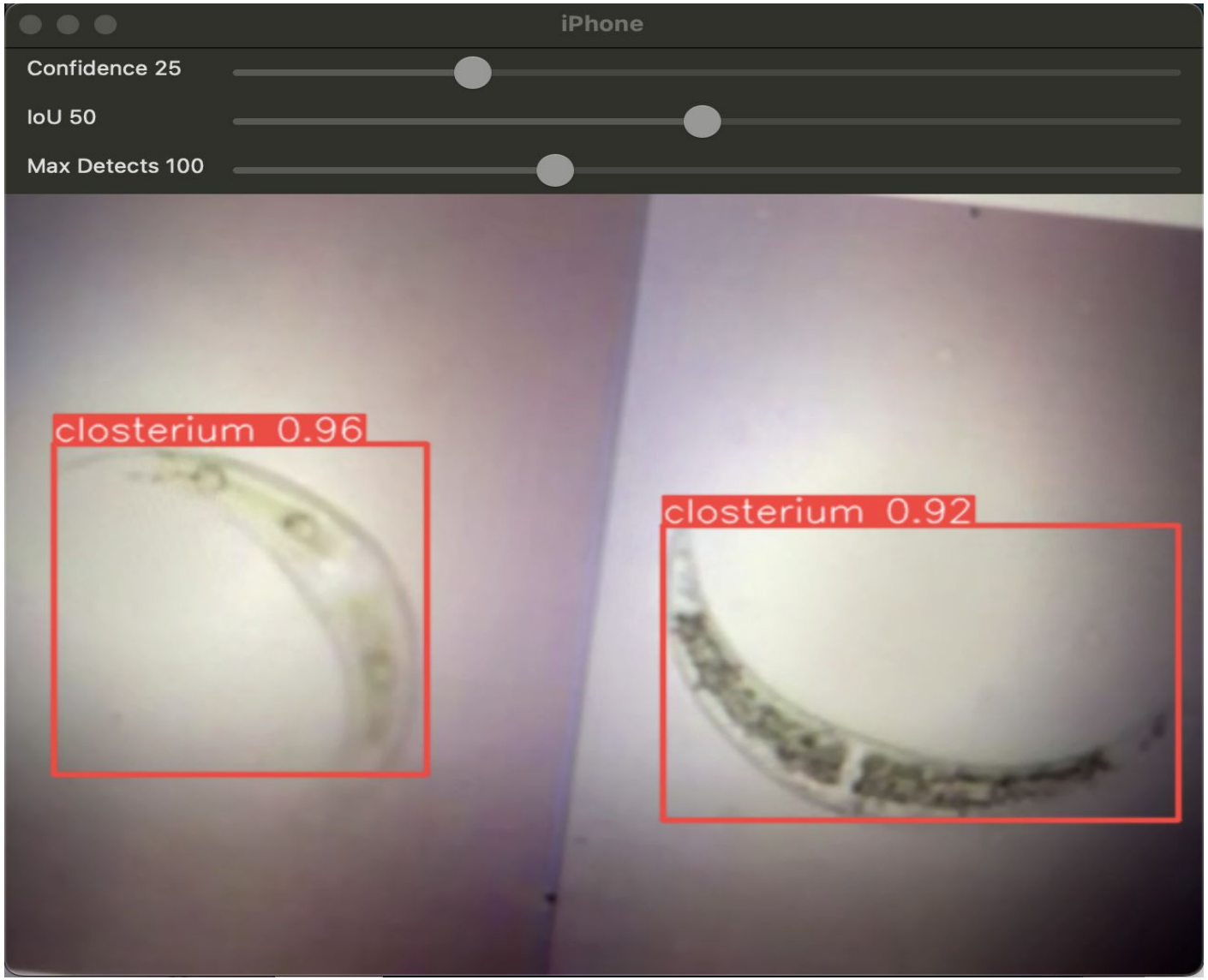
- Split
  - Training: 0.88
  - Validation: 0.08
  - Testing: 0.04
- Epochs: 25
- Optimizer: Adam

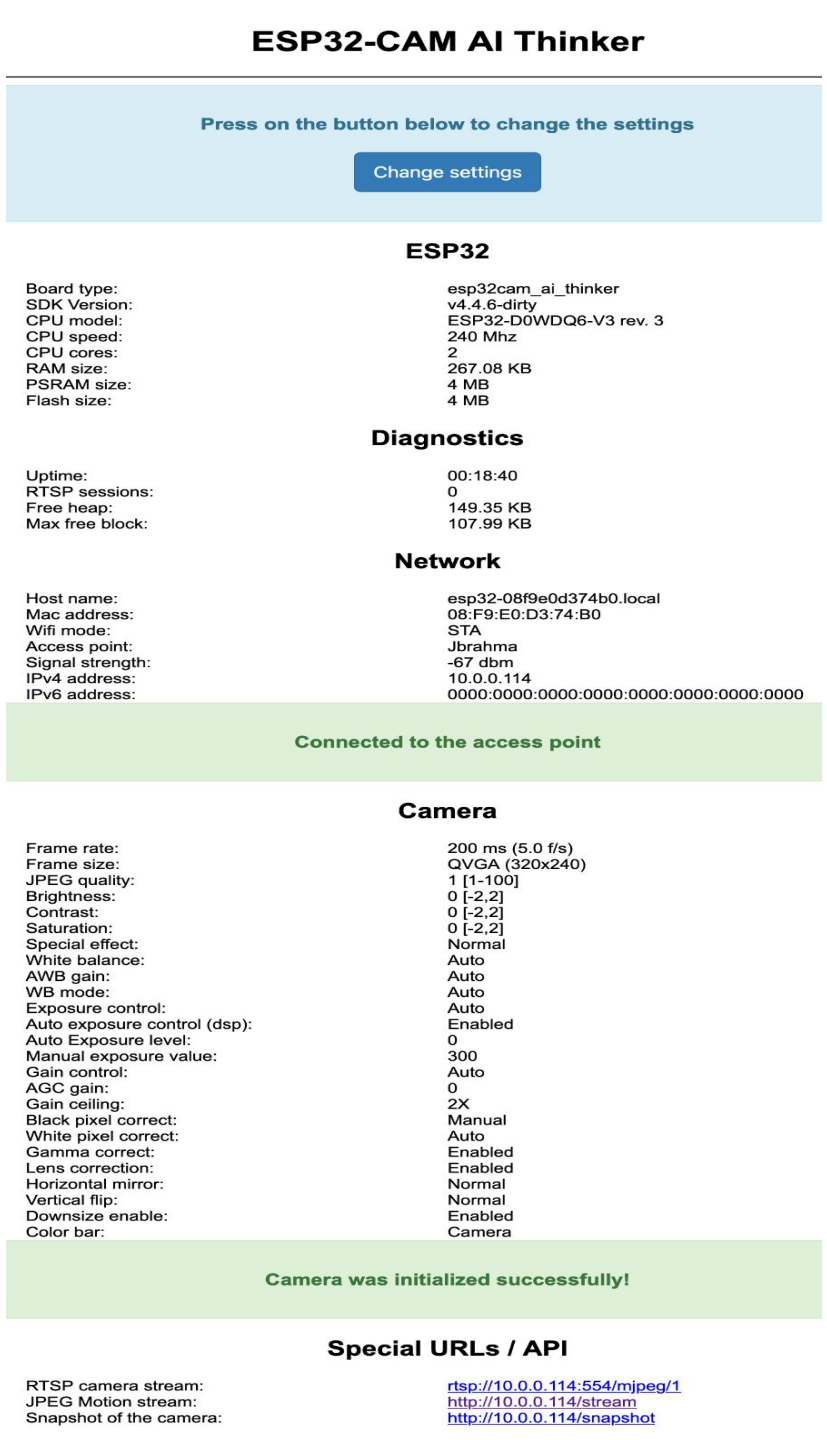




Sample Output

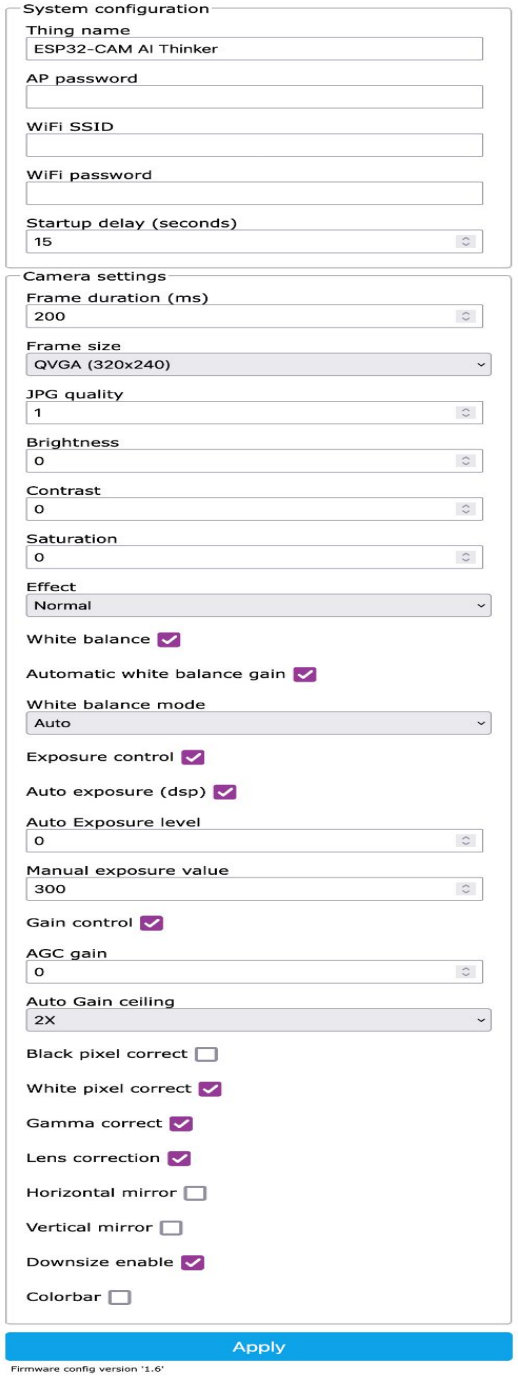
User Interface





User Interface: ESP32-CAM

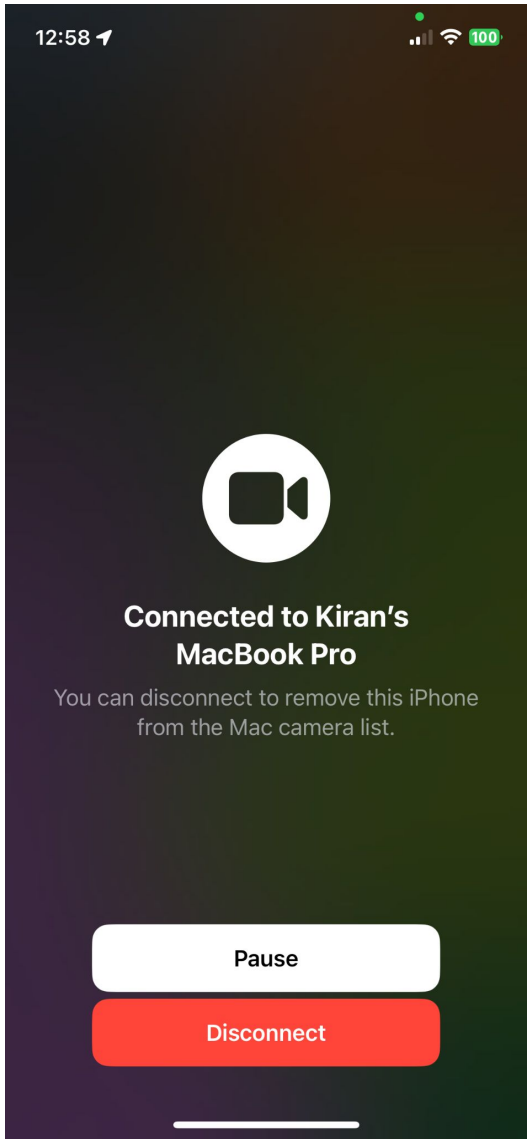
- Streaming server's home page
- Includes hardware, diagnostics, network, and camera information
- Includes links to HTTP server, RTSP server, and snapshot

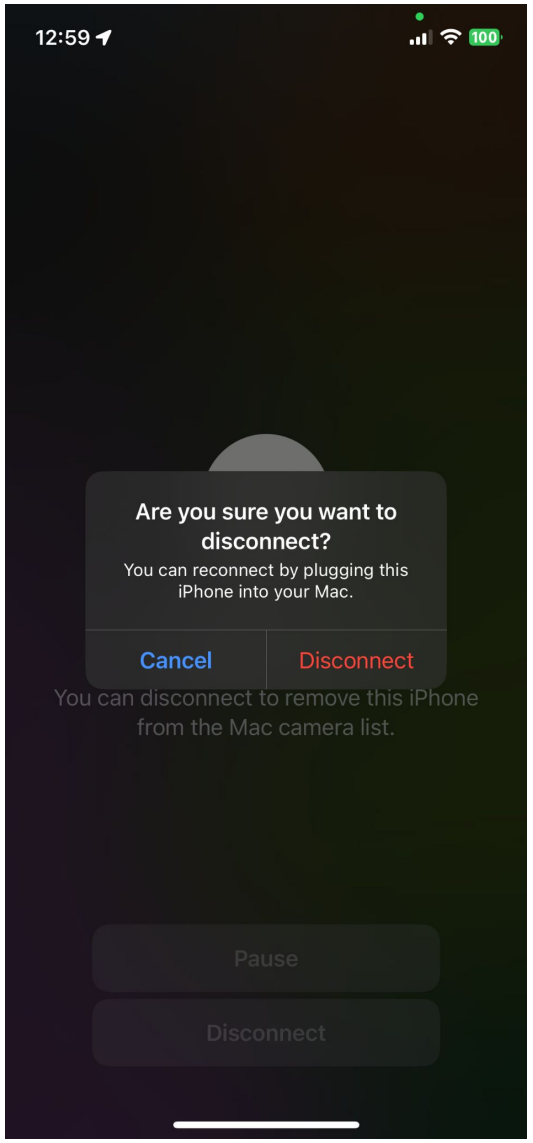


User Interface: ESP32-CAM

- ESP32-CAM's configuration options
  - Brightness
  - Contrast
  - Saturation
  - Stream quality
  - Exposure
  - Frame rate
  - Frame size
  - White balance mode
  - And more

User Interface: iPhone





Conclusion

- A convolutional neural network was trained on a large dataset of closterium, nitzschia, microcystis, oscillatoria, and non-algae
- This algae detection model allows users to quickly and easily classify algae with the ESP32-CAM, or even their smartphone
- Flexibility has greatly increased due to the model switching from a classification model to an object detection model
- The best focus for future work would be to increase the dataset drastically and to engineer a heatsink for the ESP32-CAM to mitigate overheating, thus improving performance