The Challenges of Detecting Eurasian Watermilfoil with a Pseudo Labeling Semi-Supervised Convolutional Neural Network

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Introduction

- Eurasian Watermilfoil (EWM) is an invasive aquatic plant found in many bodies of water in Minnesota
- The current way to identify EWM is visually from above the water. Once identified the area is then treated with a herbicide, 2-4-D, which can damage native plants as well.
- After treatment for EWM, the waterways are rendered unusable for weeks due to the toxicity of 2-4-D.

Motivation and Objective

- Design a deep learning model that can be used on a Autonomous Underwater Vehicle (AUV) that can identify EWM. This can provide a better way to identify EWM and reduce the amount of herbicide used.
- Test the efficiency and accuracy of semi-supervised convolutional neural networks (CNNs) when using pseudo labeling.

Hypothesis

- Using a pseudo labeling semi-supervised convolutional neural network that uses yoloV4, will lead to better detection of Eurasian Watermilfoil than if the model was trained with a supervised convolutional neural network, as determined by the mean average precision (mAP) scores.

Pseudo-Labeling on Diver Dataset

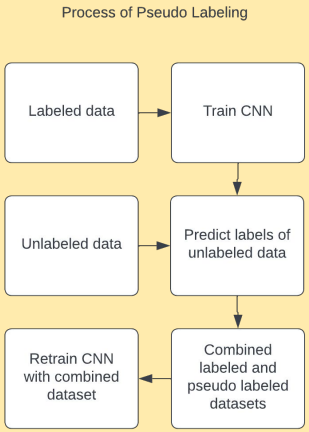

Figure 1. Supervised

Figure 2. Pseudo Label

- Figure 1 was trained for 7.05 epochs on only labeled data. The mAP after 7.05 epochs was 18.23%.
- Figure 2 was trained for 3.95 epochs on labeled and pseudo labeled data. The mAP after 3.95 epochs was 23.92%.
- The bounding box on figure 2 is more tight around the diver than figure 1 giving a better detection. The confidence for figure 1 was 28% and figure 2 was 37%.
- Although these detection rates are low, with more time and training they would increase. Overall pseudo-labeling decreases labeling time and increases accuracy.

Challenges of Detecting Eurasian Watermilfoil

- Pseudo labeling did not work with EWM because there was not a large enough dataset of underwater imagery.
- Supervised learning was tried to see if a CNN can detect EWM from other aquatic plants.
- Supervised learning yielded some detection although the detection confidence range was from 0% to 10%. The supervised learning mAP was about 12.34% at best.
- These issues stem from the data scarcity in the EWM dataset. In total there was 492 underwater images of EWM.

Discussion

- Pseudo labeling tends to improve a CNN's detection when the dataset is large enough as shown by the diver dataset.
- Supervised learning is the better method when there is a problem of data scarcity because for pseudo-labeling to work, the model must first be able to detect the object from the labeled dataset. If there is not sufficient labeled data, pseudo-labeling will fail.
- A pseudo-labeling semi-supervised CNN can be used on a dataset of underwater organic objects given the dataset is of sufficient size.
- Repeating the pseudo labeling process multiple times can increase accuracy.

Future Work

- Build a large underwater Eurasian Watermilfoil dataset
- Further optimize the process of pseudo-labeling into one process, as my process involves several steps.

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