Roadside Detection for Mapping of Navua Sedge

A Deep Learning Approach

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AUTOWEED

HINCHINBROOK SHIRE COUNCIL

Project Goal

Navua sedge is an aggressive weed that hinders the quality of pastures and crop fields, mainly found between Cairns and Townsville.

This project, aimed to find the appropriate deep learning approach to perform a more effective method of mapping instances of Navua sedge found alongside Hinchinbrook Shire Council roadways.

Methodology

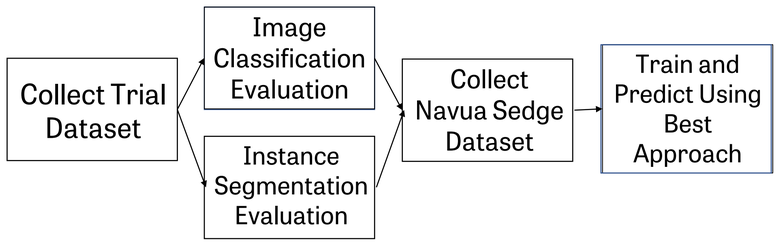

Figure 1: Overview of project methodology

Segmentation, which was shown to be the optimal approach, was then applied to a Navua sedge dataset with three different variations:

1. Dataset using only positive images (Original)
2. Using the same dataset, but cropping to remove background, shown in Figure 2 (Cropped)
3. Using a mix of positive and negative images cropped (Cropped with negatives)

Figure 2: The highlighted area of the image was cropped

Each dataset had two test sets: one consisting of 5 positive labeled images, and another consisting of 50 negative images. The image count may be low, but as segmentation is a per-pixel approach each image contains over 1 million pixels.

Results

Evaluation of trial dataset showed segmentation to have far greater recall when trying to identify a target within a previously unseen roadside image, Figure 3. Table 1 shows segmentation results across Navua sedge datasets

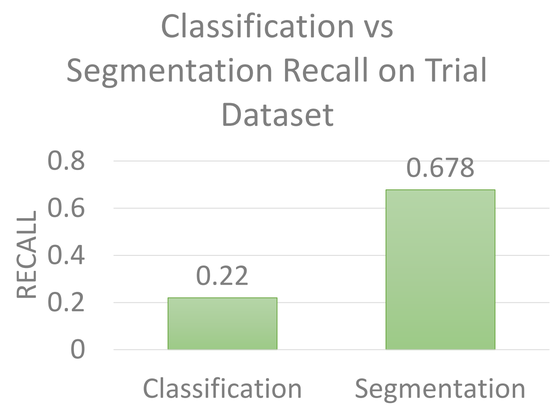

Figure 3: Classification vs Segmentation recall on trial dataset

Table1: Precision and False Positive count across Navua sedge datasets

Dataset	AP @ IoU=0.5	AP @ IoU=0.5:0.95	Mislabeled Negative Images
Original	1	0.776	48
Cropped	1	0.552	1
Cropped with negatives	1	0.566	10

Cropping without adding negative images was determined as the best method of training and evaluation for segmentation on the Navua sedge dataset due to low false positives on negative images.

A comparison between a hand drawn label and the predicted mask can be seen in Figure 4.

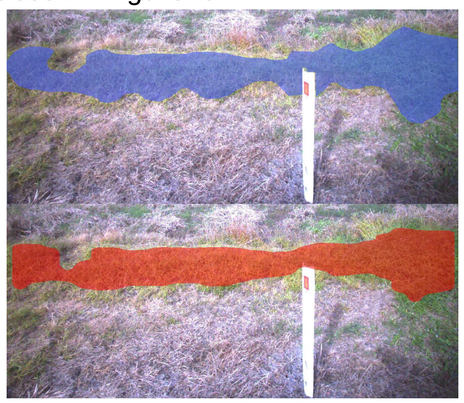

Figure 4: Manual label (Top) – Predicted Label (Bottom)

The model was then used to predict Navua instances across all images gathered, shown in Figure 5.

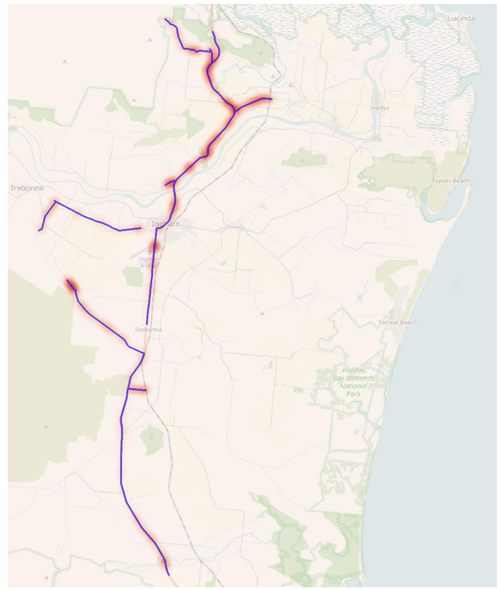

Figure 5: Points of all collected Navua sedge data (Blue) – Heatmap of predicted Navua sedge instances (Red)

Conclusions

- Segmentation combined with cropping found to be best roadside approach
- Model had high false positive rate across all data, leading to detection of other grass species, Figure 5
- Low camera resolution left a large portion of images unusable

Future recommendations include using a higher resolution camera with a constrained field of view and investigating new image augmentation techniques to balance positive and negative pixel distributions.

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