Flea Beetle Detection on Sticky Traps Using a Convolutional Neural Network

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Introduction

- Flea beetles (Coleoptera: Chrysomelidae) are a major threat to western Canadian canola production.
- Field infestations may rise drastically within a day, causing irrevocable yield loss with minimal time for corrective measures.
- Sticky traps have utility in monitoring and may facilitate automated monitoring on an otherwise mobile target.
- The objective was to test a convolutional neural network to detect flea beetles on sticky traps.

Figure 1: a. Second generation striped and crucifer flea beetles leave feeding pits on a canola leaf. b. Two, first generation crucifer flea beetles on canola seedlings.

Methodology

Preserved yellow sticky cards (780) from previous research trials at the AAFC Saskatoon Research farm were photographed in two light conditions. Images were annotated by hand to identify four categories: 1) striped flea beetles, 2) crucifer flea beetles, 3) tiny aspen flea beetles, and 4) unknown flea beetles. An unknown category was included due to identification issues when beetles were captured on their back. The convolutional neural network used was You Only Look Once Version 3 (YoloV3) (Redmon et al. 2018). The dataset was split into an 80/10/10 ratio for training, validation, and testing. Hits, misses, and false hits were accumulated to calculate precision, recall, and F-score metrics.

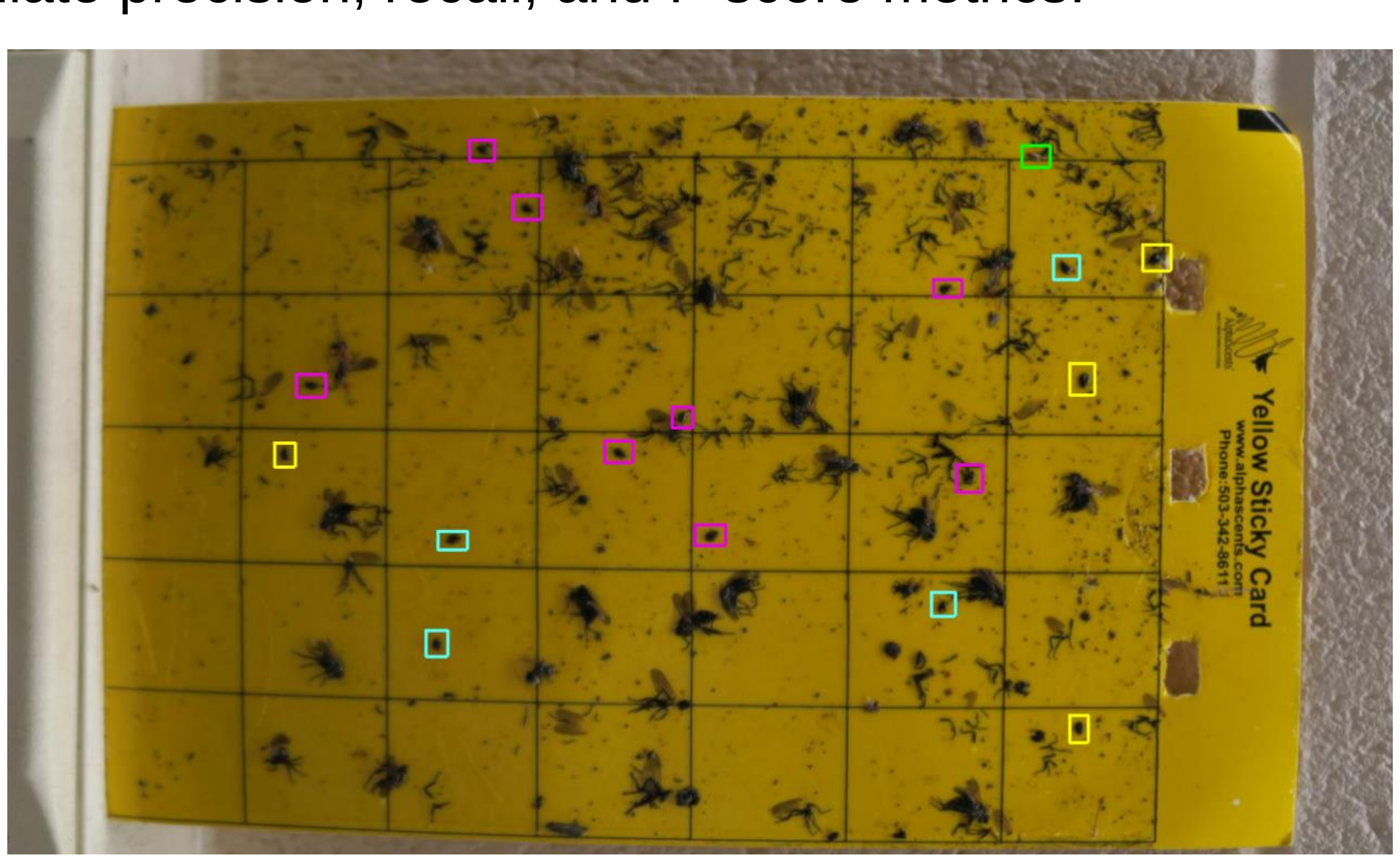

Figure 2: Example annotations for the sticky trap digital image for the striped flea beetle (purple), crucifer flea beetle (yellow), and the unknown category for beetles on their back (white).

Results

Good training fit for YoloV3 (Table 1) was achieved with the sticky trap dataset. Species discrimination was limited, with misclassification primarily between species. When considering detection of any beetle, the model demonstrated a high precision (Table 1) despite target size in relation to the card and a potentially complex background (Figure 3).

Table 1. Flea beetle detection using YoloV3.

Metric	Training	Testing	
		By species	Any beetle
Precision	0.90	0.66	0.93
Recall	0.97	0.45	0.65
F-score	0.93	0.53	0.76

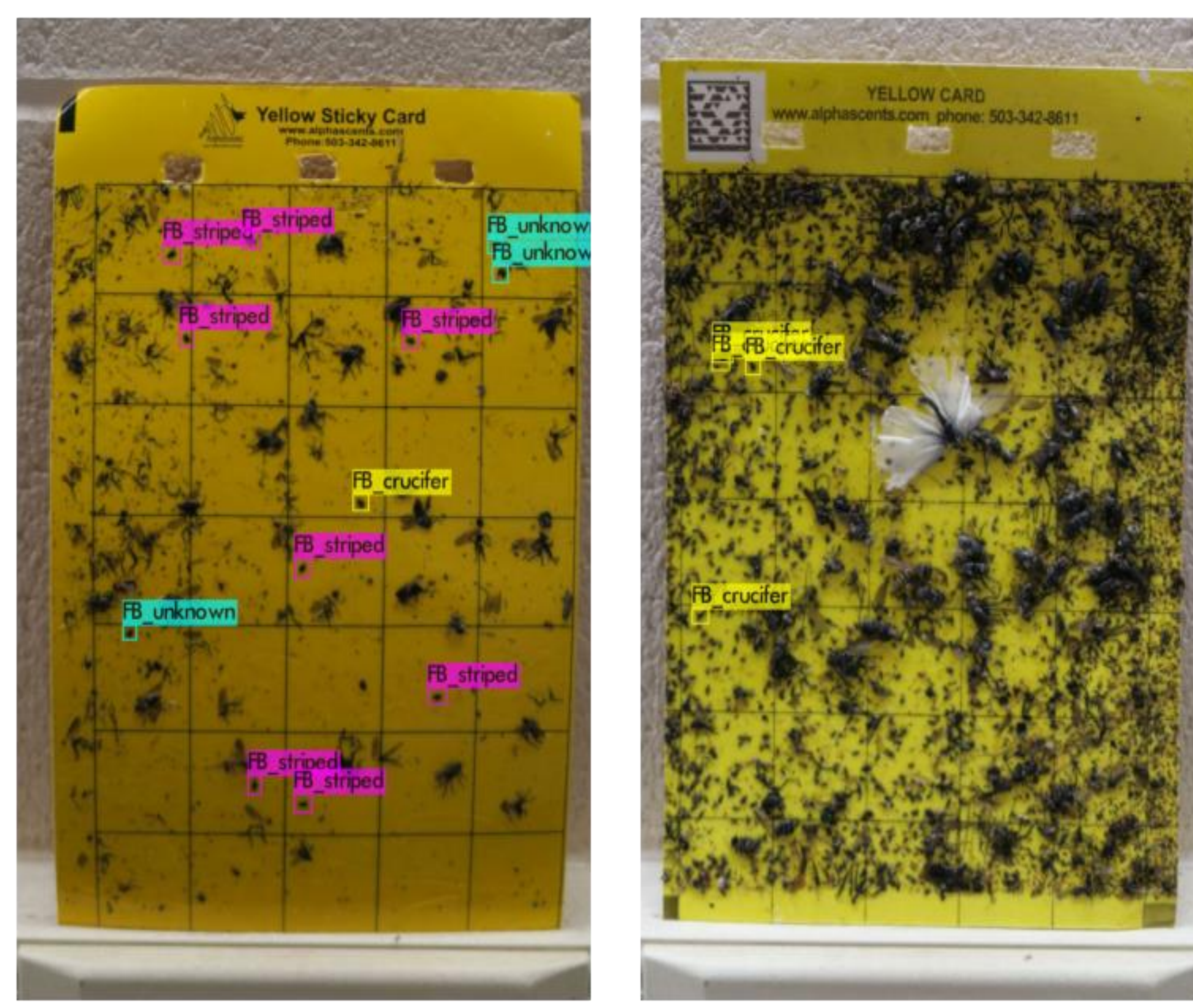

Figure 3: Example YoloV3 detections for flea beetles on yellow sticky cards.

Conclusions

- Precise flea beetle detection was feasible using a convolutional neural network.
- Flea beetle species discrimination was challenging.
- Additional imagery datasets will be developed to increase samples for each species and for external validation.
- Alternative neural networks will be evaluated to maximize detection capabilities.

References

Redmon, Joseph, and Ali Farhadi. "Yolov3: An incremental improvement." *arXiv preprint arXiv:1804.02767* (2018).