

Precision Optical Weed Recognition and Control

Hongbo Zhang¹, Arnold Douglas¹, Robert Jablonka¹

¹. Department of Engineering Technology, Middle Tennessee State University, Murfreesboro, 37132, USA
hbzhang@mtsu.edu, dra3e@mtmail.mtsu.edu, rgj2q@mtmail.mtsu.edu



Abstract

Weed control represents one of the most significant challenges of modern agriculture. Crop yield loss due to poor weed control is as high as 32%, globally.

Weed removal with optical source such as UVC lamps and high-power LEDs is promising. It represents a new paradigm of weed removal.

We propose a novel weed control method with laser and weed control with Ultraviolet C (UVC) and Infrared (IR). Results show the methods are promising. With only 5 seconds of radiation, weed has been effectively controlled.

Introduction

Directed energy weed management is successful in weed management. It includes

- Flame weeders
- Infrared weeders
- Steaming weeders
- Microwave
- Solarization

Study showed that conventional methods are energy intensive while suffering precision issue in delivery of the weed control intervention.

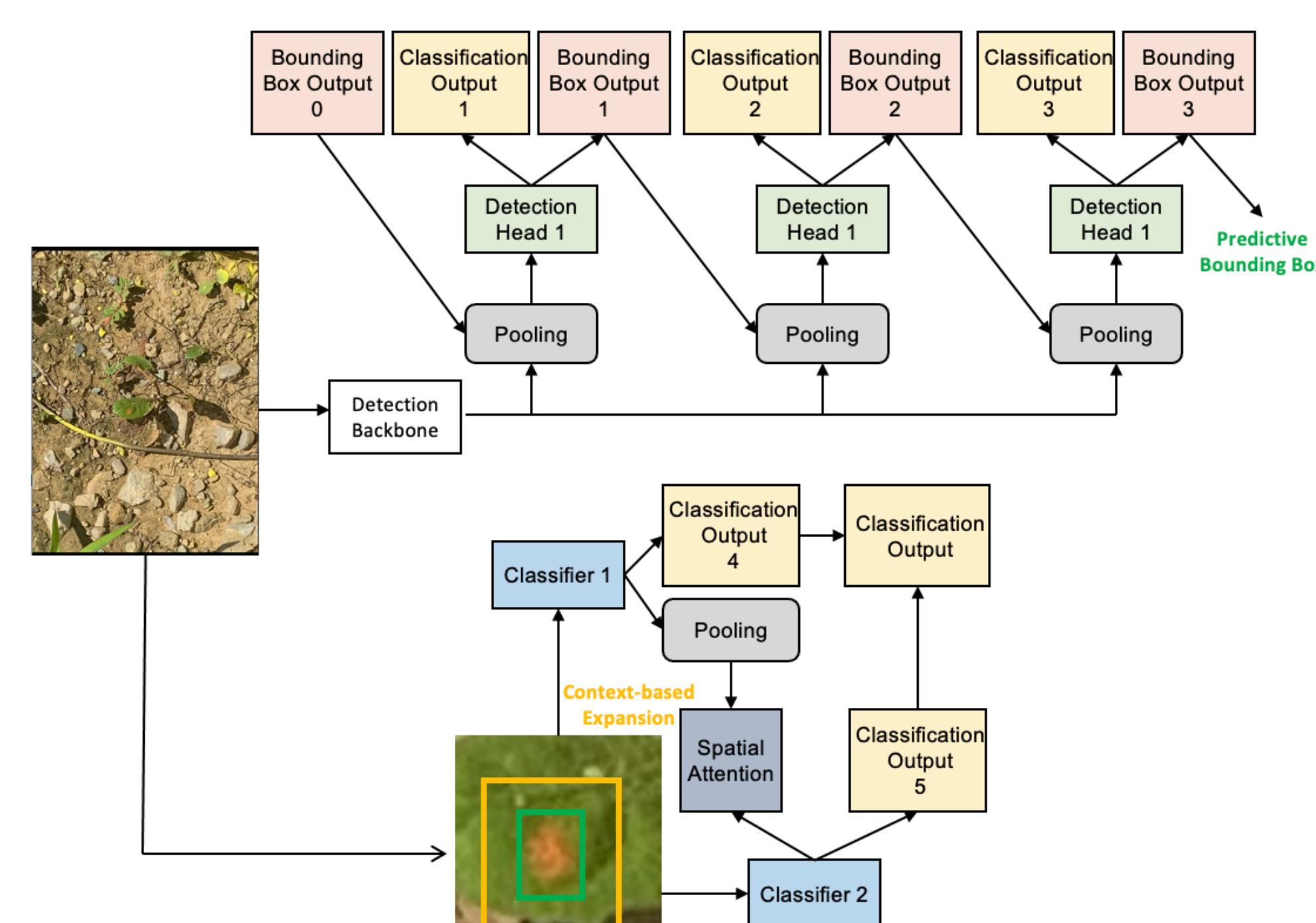
High precision weed recognition is desirable. Similarly, high precision weed recognition should be used in conjunction with weed control method to make it more effective for practical usage.

Methods – Weed Recognition

WE used LED projection on weed. It consists of visible and near infrared light in the range of 500 nm to 1500nm. The distance between LED and weed is 3cm. The LED was applied for 10 seconds on the dandelion weed. The data collection lasts 4 days after LED based weed treatment. Following the 4 days of data collection, data processing is followed.

Fine grained cascade network is used for detection. The network backbone uses a ResNet-50. Overall, it is implemented with four stages. The first stage is Region Proposal Network (RPN) followed by three stages of detection heads. The three detection heads progressively increase IOU thresholds of 0.5, 0.6, 0.7.

The progressively increasing IOU ensures the rejection of the false positives of the laser projection. The network output both localization of the laser projection using its regressor and classification heads.

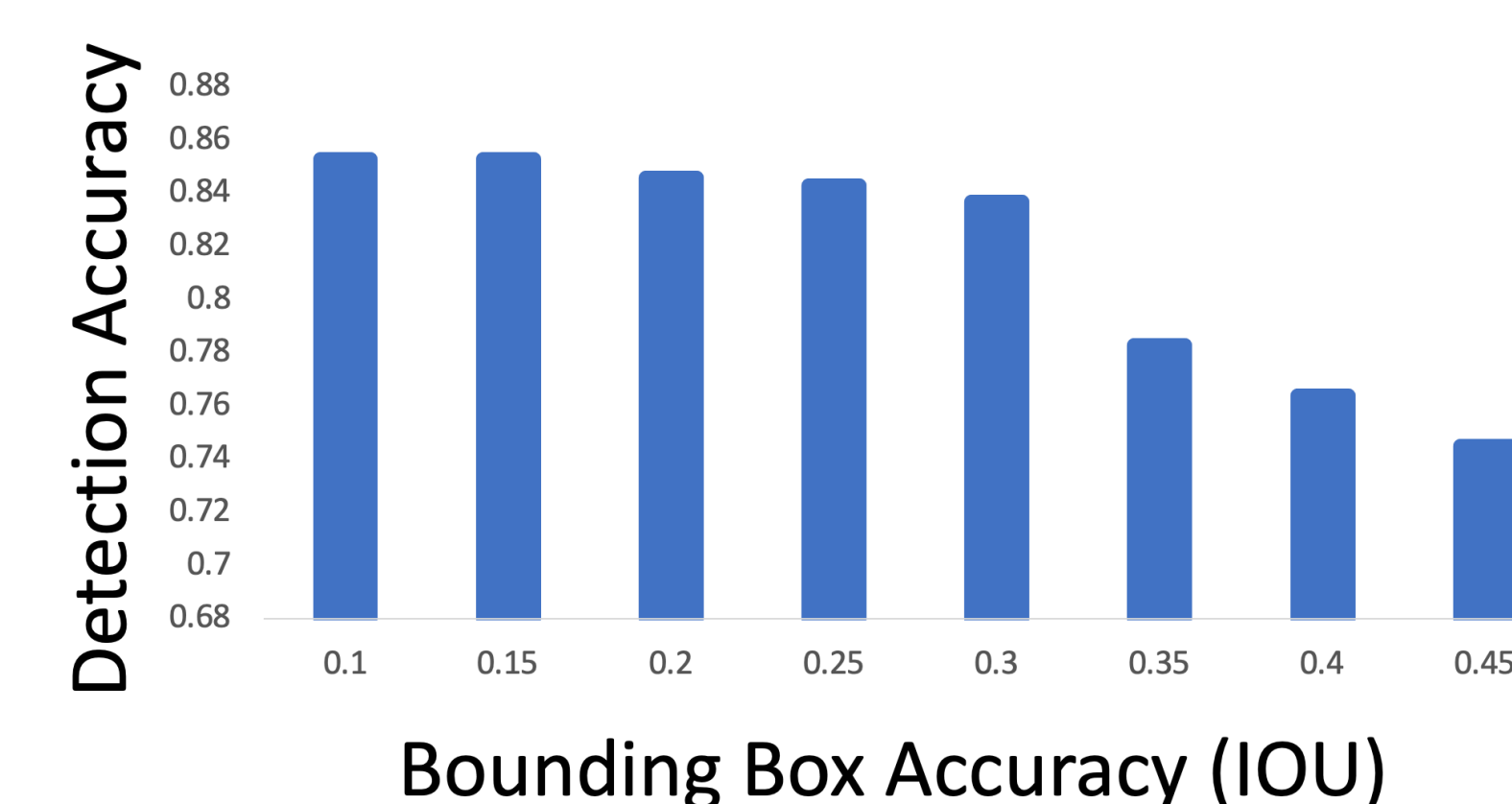


Methods – Weed Control with UVC

We have performed the weed control using customized UVC light. Among them, we have developed customized light sources. It includes UVC light source, UVC + IR light source, and IR light source.

For each light source, we have characterized the light source for the radiation. Consequently, the light source was applied to weed and soybean for 5 seconds. An observation of the responses of the weed and soybean upon the application of the light is photo taken as the evidences of the weed control.

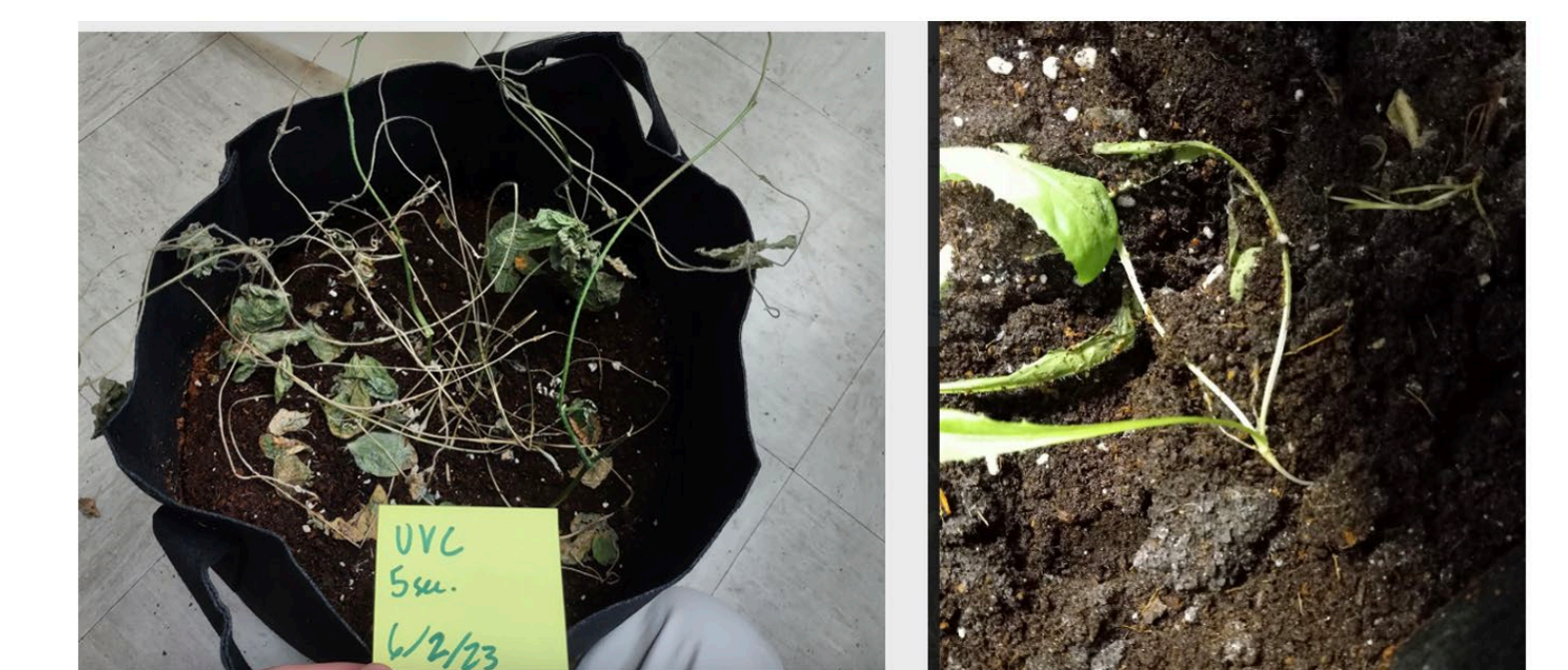
Results - Weed Recognition



Results – Weed Control



Indoor: UVC 5 Seconds



Soybean

Weed

Outdoor: UVC + Infrared 5 Seconds



Before Treatment After Treatment

Acknowledgements

(1) USDA NIFA and Funded by SARE (2021-38640-34724 - SUB00002842
(2) NVIDIA Hardware Grant Program